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SVIC NOTES

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VIBRATION POLLUTION

Over 1.2 million industrial workers per year in the U.S. are exposed to potentially harmful "hand-arm" vibration on the job. Typical sources of high vibration are chain saws, grinders and pneumatic chipping hammers.

If the hand is subjected to sustained high vibration levels, then eventually the fingers are likely to develop a defect in their blood supply which leads to attacks of Vibration Induced White Finger (VWF) or occupation Raynaud's disease. The symptoms of an attack of VWF, which may last an hour, are numbness in the fingers, along with pain and paleness of the fingertips. VWF does not result from occasional use of vibrating tools, but from prolonged use, such as that which is normally found in industry. The symptoms of VWF don't appear until one is exposed for a few weeks to several years, depending on the nature of the work process. There is a limited amount of experimental evidence which suggests that the higher the daily "dose" of "hand-arm" vibration one gets on the job, the quicker one is likely to develop VWF. The extent to which recovery occurs, if at all, when the exposure ceases is unclear.

The statistics on the incidence of VWF are cause for some concern. In some industrial environments, 100% of the workers have the disease. It takes only six months for some workers to develop the disease with a time delay of one to fifteen years being more typical. Most cases cause social disablement rather than an inability to work, but occasionally severe impairment may occur. A few cases of gangrene in the fingers of severely affected workers have been reported.

U.S. Government regulatory agencies are actively gathering information and funding research in order to more clearly define the extent of the problem. This information is badly needed by standards groups and regulatory agencies. At some point in the future, perhaps when we have a better understanding of the phenomena, some guidelines and/or standards for hand/arm vibrations will be established much like the current laws governing noise exposure and pollution. The standards could govern vibration exposure time and level as well as the maximum "emitted" vibration amplitude of a power tool handle. In fact other countries appear to be ahead of the U.S. in this area. The U.K. has had a proposed draft standard since 1974, Czechoslovakia has their Regulation No. 33, the USSR had a Hygiene Regulation back in 1955 and put out a newer version in 1966.

Surveys for VWF in workers could be performed in the work place in a manner similar to the way hearing loss is currently monitored. A potential screening survey technique has been developed in Japan by Tadayoshi Sakurai* which would allow a quick test for VWF by measuring the rate at which the temperature of the fingers recover after a test subject briefly grips a vibrating handle. The skin temperature rises quickly for a healthy person, but slowly for someone with VWF.

The question of what to do until laws and regulations are enacted is one that has several answers. First, an examination of any proposed or enacted standards should be made to gain some idea of what the potentially damaging levels of exposure are. Second, since it is a known fact that reducing the vibration amplitude will delay the onset of (or perhaps prevent!) VWF disease, installing vibration reduction handles on potentially dangerous tools would be prudent. Third, ignorance is not bliss in this matter! In the future perhaps vibration pollution will have achieved the same status as noise pollution with all its regulations. But even though there is no vibration standard or law yet, it would be wise to examine the 1.2 million workers to determine exactly how many people have VWF in this country.

In conclusion, I feel that the public should be more well educated about the harmful effects of vibration pollution and methods for reducing its impact. Also the government, industrial organizations and standards groups should move with deliberate haste towards gathering data, making laws and informing workers in this matter.

J.G.S.

*Sakurai, Tadayoshi, "Vibration Effects on Hand-Arm-System, Part 2. Observation of Skin Temperature," Industrial Health, Japan, 15 (59), pp 59-66 (1977).

EDITORS RATTLE SPACE

LITERATURE REVIEWS

We are currently expanding our group of active reviewers for the SHOCK AND VIBRATION DIGEST. These engineers have accepted the responsibility of reviewing the literature in a limited technical area in three-year cycles. The complete guidelines for literature reviewers can be found on the inside back cover of the DIGEST. If you are interested in assuming the responsibility for reviewing a technical area, please contact me, so that we can discuss your proposed topic.

The definition of a literature review is pertinent. Let us approach the definition in a negative way by stating what a literature review is not: it is not a survey. A survey contains comments on all the literature on a given subject. A literature review could be defined as a selective survey; that is, it is a subjective evaluation of the published literature. Nor is a literature review a tutorial. However, brief introductory tutorial remarks are appropriate if they establish continuity and help the lay reader understand the topic. Elaborate tutorial articles and extensive survey articles are published in the DIGEST as feature articles.

Because the literature review should contain an in-depth evaluation of a small technical area, it is preferred that the reviewer be actively working in the area he chooses. Individuals working in a specific area typically evaluate the literature in that area as it is published. The literature review should therefore be a periodic written evaluation of the worker's field.

The goals of the literature review are several. They should contain information about the phenomena involved in the subject area, techniques for problem solving, and criteria for evaluating the work being done. Reviews should be written and illustrated so that extensive use of mathematics is not required. Avoiding complex mathematical formulations allows interested individuals lacking expertise in the field being reviewed to grasp salient points and thereby keep abreast of current developments. Finally, the literature review should also provide a forum for describing techiques that might be applicable to other areas.

R.E.L.

Announcement and Call for Papers

51st SHOCK AND VIBRATION SYMPOSIUM

Theme: Dynamics in Systems Development

Held at

Holiday Inn at the Embarcadero

San Diego, California

21, 22 and 23 October, 1980

Host: Naval Ocean Systems Center
United States Navy

Sponsor: The Shock and Vibration Information Center

CALL FOR PAPERS

51st SHOCK AND VIBRATION SYMPOSIUM

Dynamic problems related to shock, vibration or acoustic loads arise and must be solved in most stages of the RDT&E process for defense systems. There are no exceptions, only different problems depending upon the mission of the system and where it is deployed, i.e. air, sea, ground or space. The technology and technical information developed for the solution of problems on one kind of system may well be transferred for application to the problems of another. Thus, the theme of this symposium is centered on shock and vibration considerations in the development of different systems, beginning with the establishment of design criteria and through analysis and design, test and evaluation, and reliability assurance.

The symposium will be in the same format as the 50th, with each half day program opening with a special Plenary Lecture followed by a pair of technical sessions. Papers are sought on the latest technical developments applicable to problems on the following systems.

- Sea Systems
  - Ships
  - Submarines
  - Off-shore Structures
- Ground Systems
  - Fixed installations
  - Mobile vehicles
- Air Systems
  - Aircraft
  - Helicopters
  - Missile Systems
- Space Systems
  - Space Shuttle
  - New Generation Spacecraft

The subjects to be addressed may include any of a broad range of problem areas within the shock and vibration field. Some examples follow.

- Instrumentation and Measurement
- Data Analysis/Criteria Development
- Dynamic Design Methods
- Dynamic Analysis Methods
- Shock and Vibration Software
- Isolation and Damping
- Modal Analysis
- Modal Test
- Test Techniques
- Test Equipment
- Test Control
- Reliability Under Dynamic Loads

Keeping the theme in mind, authors are asked to share their latest advancements so that this symposium will be remembered as an outstanding forum for technical interchange.

For further information, contact: The Shock and Vibration Information Center, Code 5804, Naval Research Laboratory, Washington, D.C. 20375 - Telephone (202) 767-2220 (Autovon 297-2220): Henry C. Pusey, Director; Rudolph H. Volin; J. Gordan Showalter; Carol Healey; Elizabeth McLaughlin

SUBMISSION OF PAPERS

Those wishing to offer formal papers for the Symposium should carefully follow the instructions on the reverse side of the SUMMARY COVER SHEET (enclosed in this issue of the DIGEST). Papers may be offered either for presentation at the Symposium, or publication in the Bulletin, or both. Summaries of papers accepted for presentation will be published and distributed prior to the Symposium. Six copies of the two page (approximately 600 words) summary should be submitted. No figures should be included in the summary. Prospective authors are encouraged to submit supplemental figures and additional information which the program committee can use to evaluate the paper, but this material should not be referenced in the summary. Authors are required to furnish such a summary even if the complete paper is submitted. In general, unclassified-unlimited distribution summaries of classified papers are requested. If this is impossible a classified summary may be submitted, but this will not be published. Deadline for receipt of summaries is 30 June 1980.

CLASSIFIED SESSIONS

The Shock and Vibration Symposium provides a special platform and publication medium for authors of classified papers up to SECRET. To simplify problems of paper release, SVIC policy for the 51st Symposium is that attendance at classified sessions will be limited to U.S. citizens and others having the required clearance and need-to-know. Limited distribution papers which are accepted will likely be programmed in the classified sessions.

SHORT DISCUSSION TOPICS

This session is planned to allow progress reports on current research efforts and unique ideas, hints and kinks on instrumentation fixtures, testing, analytical short cuts and so forth. It is intended to provide a means for up-to-the-minute coverage of research programs and a forum for the discussion of useful ideas and techniques considered too short for a full-blown paper. These discussions will not be published. Accepted speakers will have 5 minues for presentation and 5 minutes for discussion. Only unclassified-unlimited distribution discussions will be programmed for this session.

Submittals should be made on the enclosed form by 15 September 1980. Acceptable presentations will be programmed as long as space is available.

CRITERIA FOR ACCEPTANCE

Papers will be evaluated on technical merit. They should describe work that advances the technology and which has not been published previously. Papers with a commercial flavor will not be accepted, however technical submissions from vendor employees will be judged without bias and on the same basis as those of other prospective authors.

PUBLICATION

For your scheduling, if your paper is offered for publication, three review copies of the complete paper, neatly typed in your own format, must be in this office by 15 September 1980. If the paper is accepted for publication, an author kit will be provided for final copy preparation. Acceptance for publication in the 51st Bulletin depends upon favorable referee review.

PROGRAM

The advance program for the Symposium will be distributed in September, together with hotel, security clearance, and registration information.

DATES TO REMEMBER

Deadline for Summaries: 30 June 1980
Paper Releases Due: 15 September 1980
Manuscripts for Review Due: 15 September 1980
Short Topics Due: 15 September 1980
51st Symposium: 21-23 October 1980

SHOCK IN SOLIDS: ARMY MATERIALS RESEARCH AND APPLICATIONS

R. Shea and J.F. Mescall**

Abstract - The Army Materials and Mechanics Research Center (AMMRC) and its assigned mission of managing and conducting the Army's technology base programs in structural materials and solid mechanics are discussed. The dynamic behavior of materials, especially to shock, forms an important part of these research efforts. The goals of AMMRC have been to provide guidelines for using existing materials and to develop new materials for armor, penetrators, and fragment devices. Existing codes for predicting the shock response of solids are discussed as well as failure mechanisms and current research efforts - both experimental and numerical. The most recent work in this area is surveyed.

The U.S. Army is concerned with the structural integrity and durability of its equipment, much of which must be capable of operating in adverse environments. The U.S. Army Material Development and Readiness Command (DARCOM) is responsible for the acquisition and fielding of this equipment and is aware of the difficulties in dealing with such environments.

The U.S. Army Materials and Mechanics Research Center (AMMRC) is DARCOM's staff laboratory for materials research and development; AMMRC is therefore concerned with the response of structural materials in adverse environments. Accordingly, AMMRC's program deals to a large extent with shock and vibration, from structural response in milliseconds, to shock in solids in nanoseconds.

Because of current emphasis on the development of fragmenting warheads, high-density penetrators, and armor to defeat high-density penetrators, this presentation concentrates on the time and pressure responses of materials used. Times up to 20 or 30 microseconds and pressures on the order of tens of kilobars are involved.

AMMRC AND ITS MISSIONS

AMMRC is one of two laboratories reporting directly to DARCOM; the other is the Human Engineering Laboratory. AMMRC is not directed to a particular type of system. Rather, its mission is to manage the Army's research and development program in structural materials and solid mechanics, as well as materials testing.

The real work of AMMRC is for the research and development commands in the sense that AMMRC's program must be responsive to their needs. In fact, in addition to responsibility for the materials and mechanics technology-base program with its longer range goals, AMMRC is expected to provide short-term, direct support to these commands and project managers within these commands and in the readiness commands within DARCOM. Figure 1 illustrates this role and shows some of the direct support activities that apply to systems under development, in production, or in the field.

An illustration of this direct support is the development of the nuclear shell. For almost two decades the Armament of Research and Development Command (ARRADCOM) has used AMMRC in the development of these shells. AMMRC's role has involved selecting and processing materials, assuring the structural integrity of shell bodies, and manufacturing structural components.

AMMRC serves as the focal point for materials research and development. Its program is thus structured along the lines of the DARCOM research and development commands; for example, the program includes Materials for Armament and Materials for Aircraft, which correspond to materials requirements of ARRADCOM and Aviation Research and Development Command (AVRADCOM). Because DARCOM's

*This paper is adapted from a plenary lecture delivered at the 50th Shock and Vibration Symposium in October, 1979, in Colorado Springs

**Department of the Army, Army Materials and Mechanics Research Center, Watertown, Massachusetts 02172

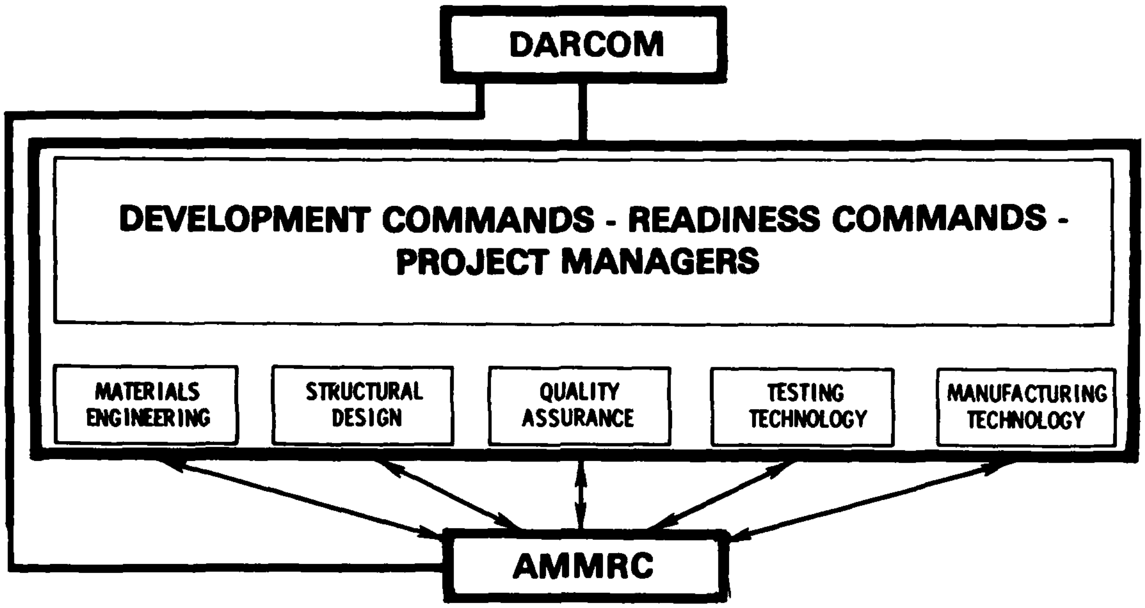

Figure 1. AMMRC Support Relationship

readiness commands are organized along the same lines, the program can be responsive to the needs of DARCOM. Thus, the dynamic responses of materials and structures are important to AMMRC. Figure 2 shows some areas that are currently emphasized in the technology-base program.

This article contains discussions of the shock mechanics aspects of fragmentation, armor and penetrator materials, mechanics of composite materials, and life prediction/reliability mechanics.

AMMRC is located at the site of the former Watertown Arsenal, about six miles west of Boston (Figure 3). In fact, AMMRC was formed by the merger of the Watertown Arsenal Laboratories and the Ordinance Materials Research Office. The aerial view of AMMRC (Figure 4) was taken from over the Charles River. AMMRC comprises the westernmost third of the old Watertown Arsenal grounds. The arsenal, founded in 1816, was disestablished in 1967. The buildings on the eastern side date from right after the Civil War to the end of the nineteenth century. Much of AMMRC's dynamic testing is conducted in Building 312, the old gun carriage assembly shop.

The facility contains a computer controlled testing system (Figure 5) to characterize metals, ceramics, polymers, and composite materials at strain rates from about 10^{-4} per second to 50 per second. Other dynamic testing facilities cover higher strain rate ranges. Included are a penetration research facility to evaluate armor and penetrator materials and a light-gas gun facility that can generate shocks in solids up to about 500 kilobars and measure responses in the nanosecond range.

SOLID MECHANICS

The goal of AMMRC's solid mechanics technology-base program is to understand how materials fail and then develop predictive techniques. Although the overall program is structured along systems-oriented lines, AMMRC is organized along discipline-oriented lines; nevertheless, mechanics of failure processes is the common thread of the program. Within the mechanics side of AMMRC this translates to life prediction/reliability mechanics, mechanics of advanced materials, and shock-impact mechanics/dynamics.

- CHARACTERIZATION OF ORGANIC COMPOSITES
- ELECTROSLAG REMELTED STEELS
- HIGH DENSITY PENETRATORS
- ENVIRONMENTAL PROTECTION/DURABILITY OF MATERIALS
- BALLISTIC MISSILE DEFENSE MATERIALS
- GUN BARREL EROSION
- METAL-MATRIX COMPOSITES
- GEAR MATERIALS
- BRIDGING MATERIALS/CONCEPTS
- CERAMICS FOR DIESEL ENGINES
- FLAMMABILITY/FIRE PROTECTION
- FRAGMENTING MUNITION MATERIALS
- ARMOR TO DEFEAT LONG ROD PENETRATORS
- LIFE PREDICTION RELIABILITY MECHANICS

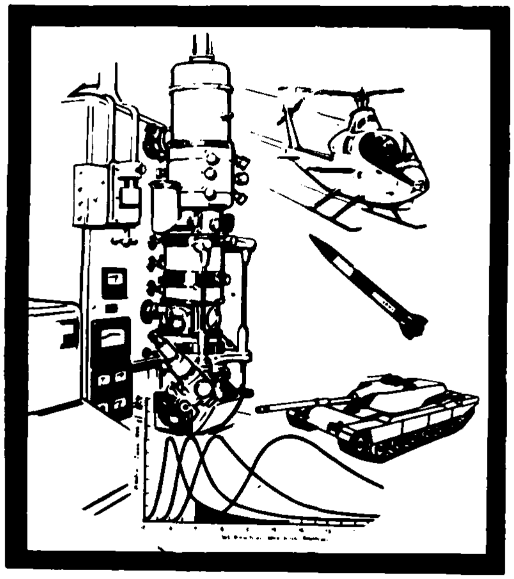

Figure 2. Current Areas of Emphasis

The objective of life prediction/reliability mechanics is to merge fracture mechanics and probabilistic-based considerations. Because Army systems must operate in increasingly severe environments, materials are being pushed much harder, and the materials themselves are much less forgiving than in the past. For example, the Army now employs a high-fragmentation steel in the warhead of the 155-mm rocket-assisted high-explosive round. This material is extremely effective on target but is inherently brittle, thereby posing difficult design issues insofar as assuring safety and reliability during rough handling and launching are concerned. The use of such materials, particularly in severe environments, complicates our ability to predict failure.

Other issues also demand attention. For example, the state of the art of linear-elastic-fracture mechanics is inadequate; elastic-plastic behavior needs much additional study, as do shear and mixed-mode fracture analyses. Another concern is the ever-increasing number of structural mechanics computer codes; conservative estimates are that more than 1,000 such codes, both general and special purposes, are now in use in the U.S. In many cases the user has no understanding of the details of the codes.

Another issue is structural integrity. In too many system development programs not enough attention was paid to structural integrity -- until problems developed. The reason probably is that some high-technology area often drives a development program, and the old line technologies of shock, vibration, materials, and mechanics are taken for granted. Structural integrity of equipment, particularly in shock and vibration environments, cannot be taken for granted and must be an integral part of any development program from inception.

Areas of concern in the mechanics of advanced materials include the behavior of ceramic materials and composite materials. Devising joint design methods is part of a general need to understand how these materials fail.

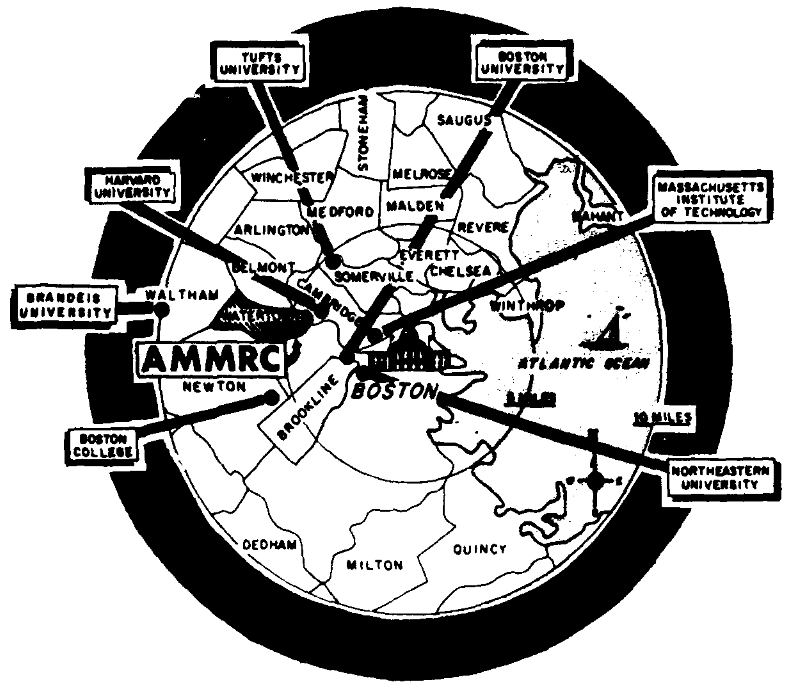

Figure 3. Location of AMMRC

Composite materials are now used in many Army systems, as are structural ceramics, but their potential has not yet been exploited for two closely related reasons. First, these materials are more difficult to characterize than are metals; hence the data base is woefully sparse. Second, the reasons for failure of these complex materials are not understood; thus, they cannot be fully exploited.

An advantage of composite materials is that they have high specific strength and stiffness and thus should be useful in developing lighter and higher performance or more efficient systems. Moreover, judicious application of these materials allows reduction of life-cycle costs. An example in which both weight and money can be saved appears to be Army tent frames. The U.S. Army Natick Research and Development Command (NARADCOM) and AMMRC are conducting a program aimed at replacing aluminum frames with glass-polyster ones in an Army tent system. The composite frame will be lighter, less expensive, and more durable than the aluminum one.

Another application of composites is mobile assault bridging. A demonstration project for metal matrix composites in vehicular-launched bridging components is already underway but will not come to fruition for several years. The U.S. Army Mobility Equipment Command (MERADCOM) and AMMRC are collaborating to introduce organic matrix composites into bridging right now. The motivation is to save weight and thus emplacement time.

The principal concern in shock-impact mechanics/dynamics is to better use available materials and to define the characteristics necessary for materials that will be used in fragmentation devices, high density penetrators, and advanced armor systems. Although AMMRC does not have the responsibility for developing such systems, materials performance in these areas is almost indistinguishable from systems performance.

The most powerful tools available for analysis of the response of materials are the so-called hydrocodes,

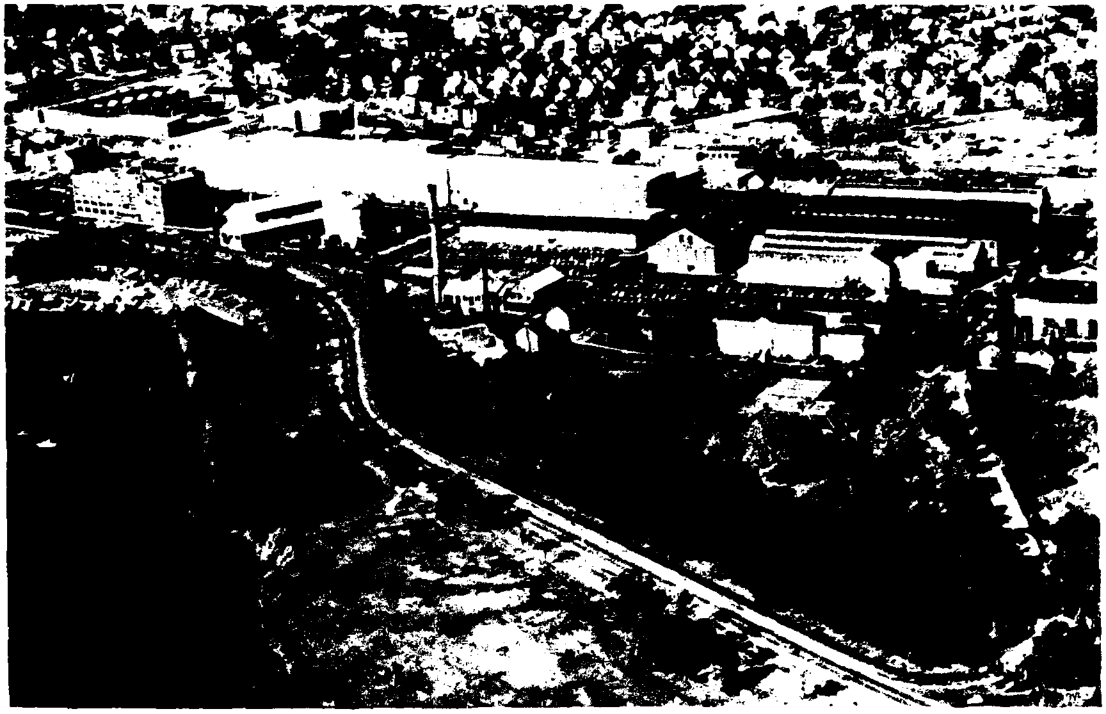

Figure 4. Aerial View of AMMRC

which were originally developed by the Atomic Energy Commission for the design of nuclear devices. AMMRC principally uses the HEMP (Hydrodynamic-Elastic-Magneto-Plastic) code, developed by Wilkins at Lawrence Livermore Laboratory [1]. These computer codes now have provisions for including material strength in the analysis.

In effect, these codes provide an excellent means for modeling shock events in solid materials, insofar as predicting wave propagation events, stresses, pressures, and strains are concerned. Details of the behavior of materials in these severe environments are lacking, particularly details of dynamic fracture. Such details are necessary if improvements in materials for these applications are to be made.

The problem is that dynamic fracture is not well enough understood to allow formulation of criteria for the codes. Existing dynamic fracture criteria are either too simplistic to be realistic or too complex to be practical. This situation is not as serious in nuclear applications because pressures are so great that material strength is insignificant. In penetration and fragmentation applications, pressures (and stresses) are an order of magnitude lower; hence, material strength and dynamic fracture are overriding issues.

Penetration and fragmentation are dynamic environments with few nonmilitary applications, so that data are sparse; a major commitment in this area is therefore essential.

Concern has been expressed with the potential for development of high-energy laser weapons by the Soviet Union. The DOD has well-coordinated effort directed toward understanding the interactions of high-energy laser beams and structural materials.

One instance in which a fairly simple dynamic failure model was used successfully involves the use of a mechanical means of wave shaping to enhance fragmentation. In a conventional fragmentation device a cylinder or other shell is filled with high explosive.

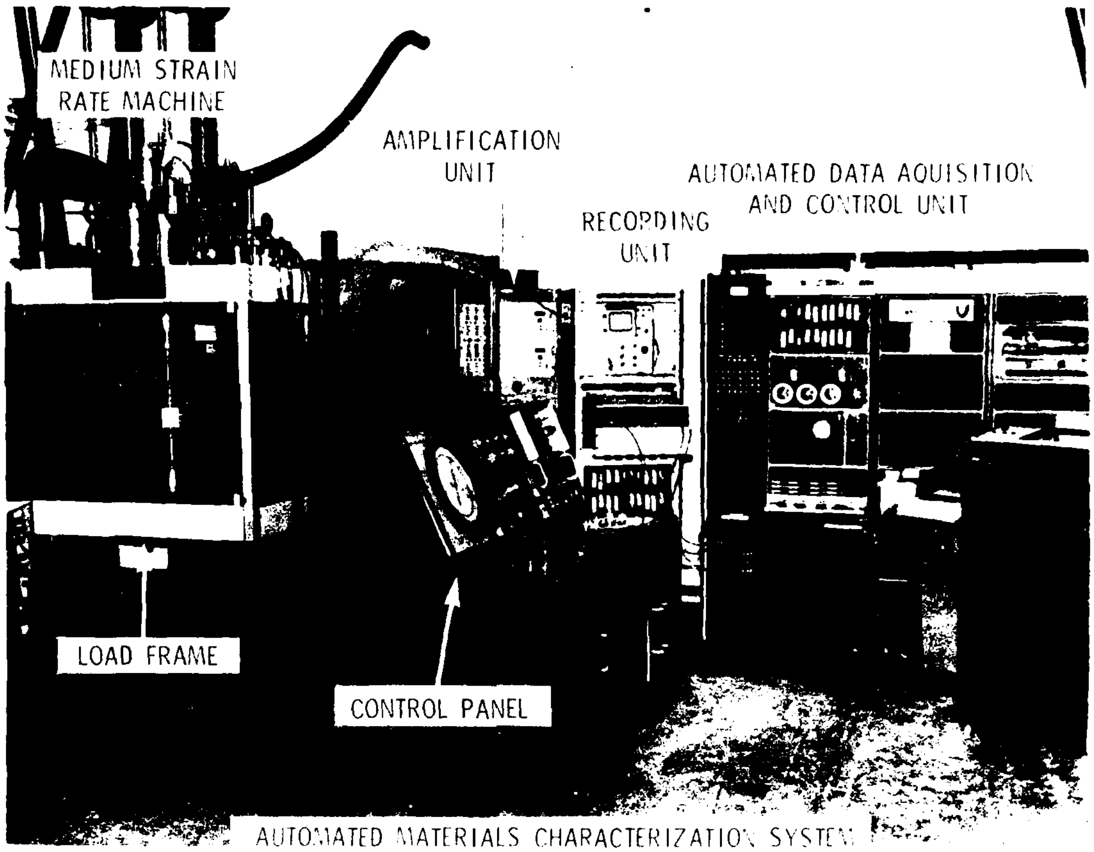

Figure 5. Automated Materials Characterization Facility

The explosive is detonated at the center of one end. The ensuing shock wave travels down the shell, resulting in a radial expansion of the shell. The fracture, or fragmentation process, occurs as shear cracks at about 45° from a radial direction, either singly or in combination with tensile cracks oriented radially; the latter originate near the outer surface of the shell.

In a basic study involving computer modeling of exploding wire experiments used to characterize the dynamic spall strength of aluminum, a capacitor was discharged across a wire in the center of the cylindrical test specimen; the procedure was used to enhance fragmentation, and the SLAPPER concept evolved (Figure 6). Two cylinders with a space between them were used; the shock wave, on detonation of the high explosive, propels the inner cylinder (or SLAPPER) across the space, and the inner cylinder strikes the outer one. Varying the radii and thicknesses of the cylinders allows the rarefaction that occurs after passage of the shock caused by the impact to be tuned; the result is that radial tensile stresses large enough to cause spall failure in the outer cylinder are produced. This spallation, or tensile fracture, in the circumferential direction, produces another mode of fracture in the fragmentation process.

The method used to tune the configuration was based on a fracture criterion suggested by Sandia Laboratories. This model uses the integral under the stress-time curve as a failure criterion. The integral can be maximized by adjusting or tuning the configuration.

The Table contains results of an experimental verification. A relatively ductile material, 1026 cold-rolled

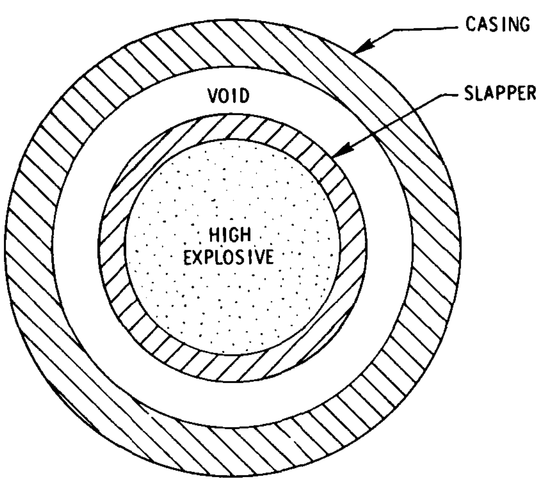

Figure 6. The SLAPPER Fragmentation Concept

steel, was compared with a high fragmentation steel, HF-1. In the conventional configuration the HF-1 yields almost three times as many fragments as the 1026-CR because the HF-1 is inherently brittle.

With the SLAPPER, a dramatic increase in the number of fragments results in both materials. The main point is that this approach allows significantly more fragments to be obtained with the relatively ductile 1026-CR than with the brittle HF-1. This implication is that the increased launch safety associated with the 1026 steel can successfully be combined with the fracture behavior required at detonation time to increase lethality.

Effect of Slapper on Fragment Count

	FRAGMENTS LARGER THAN ½ GRAIN	
	CONVENTIONAL	SLAPPER
HF-1	1200	2400
1026-CR	430	2120

PENETRATION MECHANICS/ FRAGMENTATION MECHANICS

This selection has to do with the scope of AMMRC's program in shockwave propagation in solids under explosive loading or ballistic impact conditions. The general concern is with events that occur when a long rod-shaped penetrator strikes an armor plate at velocities up to 5,000 feet per second or when a steel cylinder filled with a high explosive is detonated. AMMRC is concerned with the role played by material properties of solids in such extreme loading environments; for example, the influence of the dynamic yield strength on the interaction of penetrator, armor, or fragmentation device. Also of interest is the possible significance of the fracture toughness concept of static materials behavior.

Because full-scale testing of such weaponry is expensive, small-scale ballistic ranges and detonics facilities are used to screen materials. Orthogonal X-ray observations are made of both ballistic and explosive events. Such kinematic variables as residual velocity and residual mass of fragments when penetration does take place are of interest, as are the patterns of the fracturing process and the timing of the events.

Even though experimental observations are indispensable, the extreme pressures and short-times involved make it difficult to obtain specific measurements at the most interesting locations. Transducers attached to specimens tend to be destroyed too soon; photographic or X-ray observations do not satisfactorily discriminate between designs that differ primarily in material used. Two notable exceptions include some recent ultra-high energy X-ray observations of the penetration process and some long-rod penetration experiments. On the other hand, evidence from examinations made after tests show that, for many applications, material selection is of critical importance.

Computer simulations of ordnance applications have been extremely useful in interpreting experimental results. Such calculations provide reliable quantitative details of the stress-and-strain fields that prevail in the interior hostile environments. If the calculations are done carefully and correlated with experimental observations, the results can significantly increase our understanding of the requirements for material properties.

Simulations are based on the conservation laws (mass, momentum, and energy) coupled to an equation of state that is realistic for the high pressures and short-times involved; the finite difference formulation is integrated step-by-step in time, and the output is a detailed history in time of the physical variables of interest.

The governing differential equations which vary somewhat in form depending upon whether a Lagrangian or eulerian formulation is used [1, 2]. Details of the equation of state employed are given in the following paragraphs.

During the early development of computer codes for the simulation of explosive events, attention was focused on the hydrodynamic mode of behavior that is appropriate for pressures on the order of hundreds of kilobars (i.e., an order of magnitude above strength of material considerations). A pressure-volume relationship (the Hugoniot curve in Figure 7) is determined in a series of plate-slap experiments involving conditions of uniaxial strain. The rear surface of a target plate is monitored with a laser-interferometer technique and, from details of the observed motion, inferences can be drawn as to the material response under very high pressures in microseconds.

As experimental evidence accumulated it became clear that there was a substructure associated with

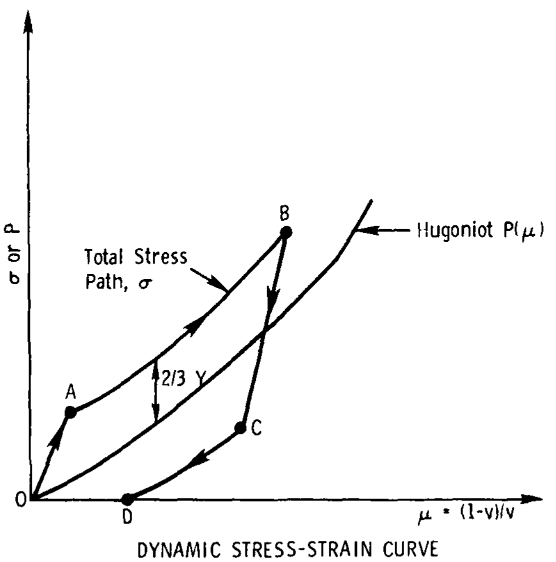

Figure 7. Dynamic Stress-Strain Curve

the stress-wave patterns generated under shock-loading conditions. For stress amplitudes on the order of the strength level of metals (tens of kilobars) an elastic-plastic behavior was superimposed on the Hugoniot curve in the model shown in Figure 7. In this model of material behavior, the stress trajectory followed by a material point is as follows: elastic response along OA (up to the Hugoniot-elastic-limit), and plastic deformation from A to B (when the amplitude of B is determined by impact velocity); as relief waves propagate into the interior, relaxation of stress at the material point occurs as a result of initial elastic relief along the path BC and, finally, plastic relaxation along CD.

Actual stress states in ordnance applications are more complex because of the location of free surfaces and multidimensional characteristics. However, the essential point is that, for stress states in the tens of kilobars, strength of material considerations become significant and are treated as a superposition on the Hugoniot P-V curve.

In scenarios involving explosive pressures or very high impact velocities, initial stress levels are on the order of several hundred kilobars. For such states the total stress path collapses onto the Hugoniot curve, and the strength of materials issues are not dominant. However, the primary point of this paper is that such conditions form only the early and very short-lived first phase of the entire sequence; that, in fact, most of the time of interest is spent in a second stage with which much lower stress levels are associated. It is also true that very little plastic deformation occurs during the first stage, but massive plastic deformation takes place during the second stage when strength of materials issues are paramount. Note that only plastic flow of materials is occurring thus far and not, as yet, fracture.

Figure 8 is an example of the results obtainable from computer simulations of shock-wave propagation in solids; some details of the detonation wave propagating down the axis of a steel cylinder containing a core of high explosive are given. Initiation of detonation occurred 4 microseconds earlier at the left-hand edge of the axis of symmetry.

Figure 9 shows details of the propagation 8 microseconds after detonation. Pressures on the order of 200 kilobars are generated in the explosive (the

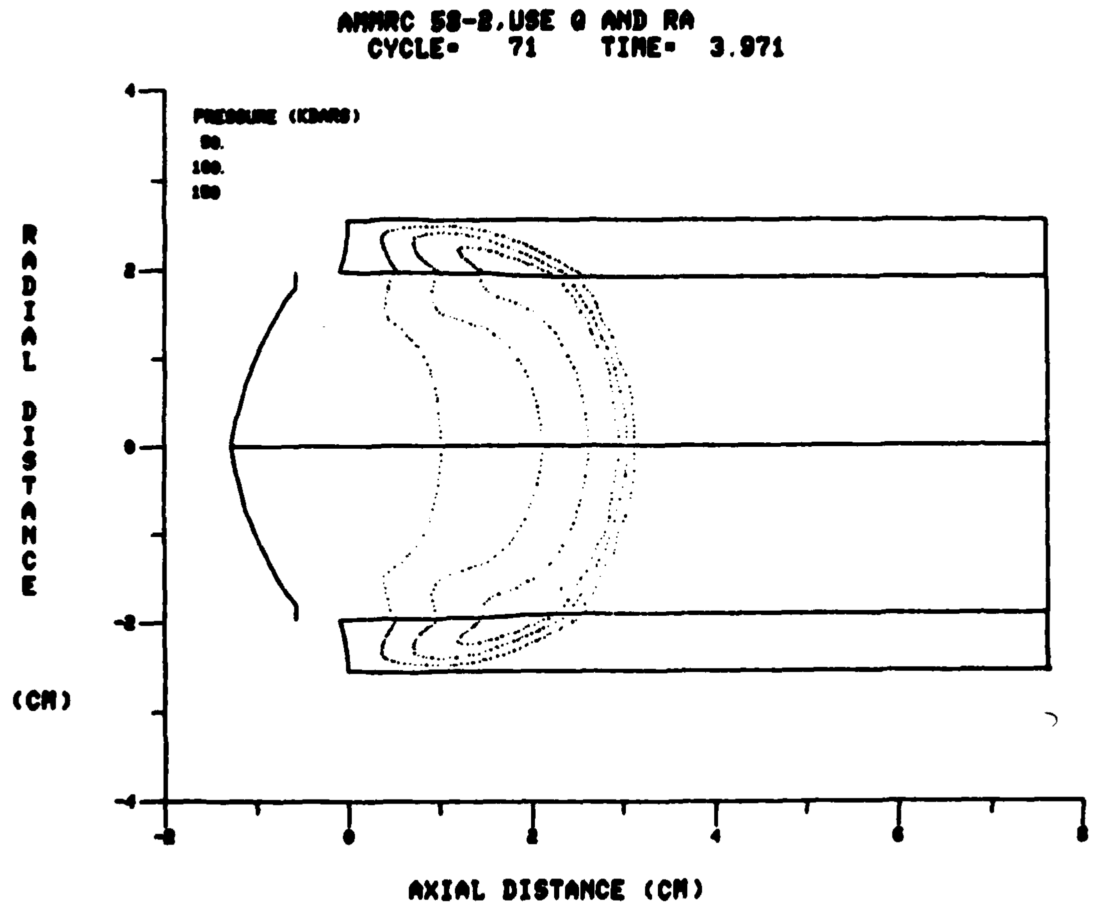

Figure 8. Computer Simulation of Fragmenting Cylinder 4 Microseconds after Detonation

Chapman-Joguet pressure characteristic of the explosive) and transmitted onto the steel casing. Relief waves propagate into the pressurized zones very quickly. Figure 9 shows details of the initial outward expansion of the steel casing, further propagation of the detonation wave (peak pressures have not quite reached the right-hand side of the cylinder), and the effect of the rarefaction waves. Of special interest is that the outwardly moving left side of the steel casing is subjected to very low internal pressure from the gas products of the explosion; in fact, the internal stress states in this region of the steel is actually in a modest tension field of amplitude (10 kbar tension is indicated by the heavier contour lines).

An indicator of the credibility of these details of internal stress and deformation is the fact that the velocities predicted by the calculations for the metal parts are within five percent of experimentally observed velocities.

Another illustration of computer simulation is shown in Figures 10, 11, and 12. The problem is that of a steel cylinder impacting a steel target at 2,500 feet per second. Contour plots of pressure are shown at 1, 2, and 3 microseconds after impact. Details of a rarefaction wave can be seen entering both target and projectile from the lateral surfaces of the projectile long before the initial wave reaches the projectile rear surface. These rarefaction waves can produce tensile stress states in both projectile and target at very early times, as shown by the darker contour lines in Figures 11 and 12.

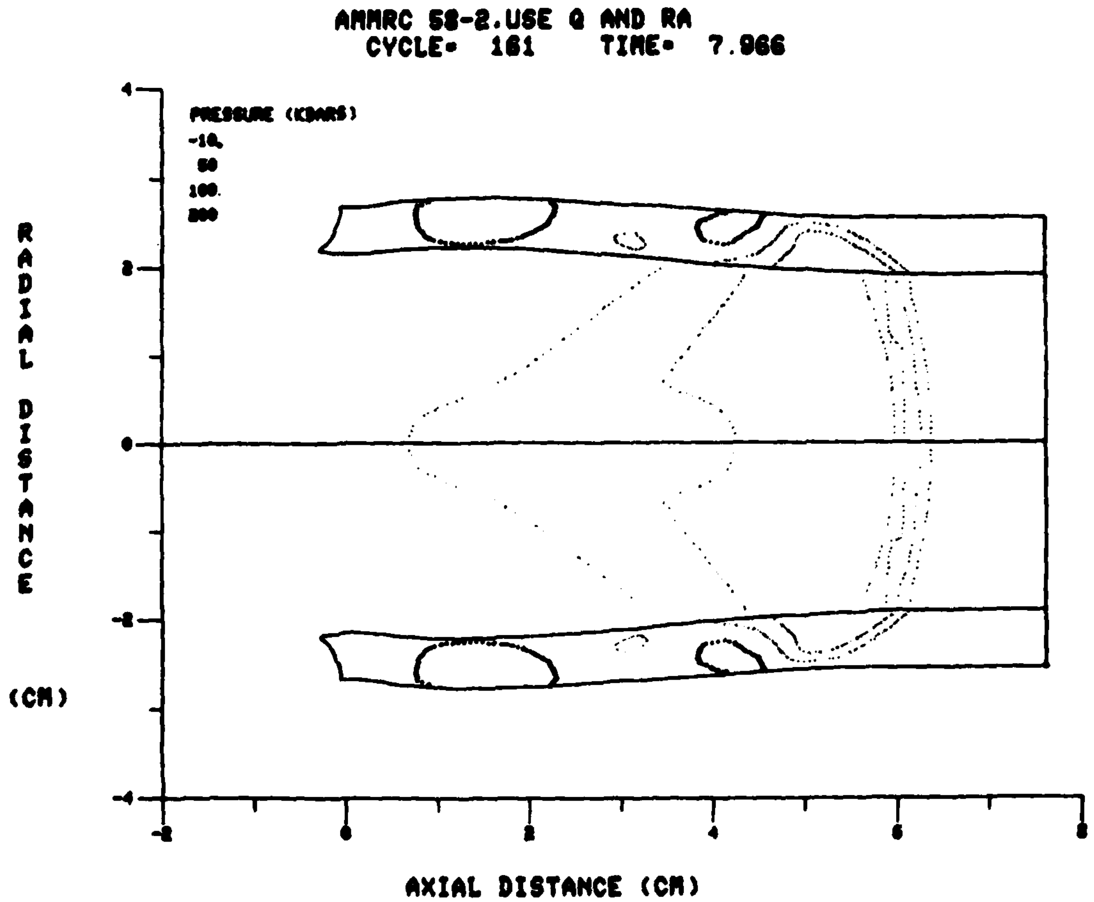

Figure 9. Computer Simulation of Fragmenting Cylinder 8 Microseconds after Detonation

Whether these tensile stresses produce fracture depends largely upon the dynamic tensile strength of the material. Correlation with experimental observations reveals that lower strength steels -- e.g., those with a hardness of RC 20 -- tend to have low dynamic tensile strengths and are vulnerable to spall fracture. High-strength steels (e.g., RC 50) are far less vulnerable to spall in the simulation above. A detailed comparison of the simulations and the experiments is available [3].

If ballistic penetration depended upon tensile failure, it might be expected that higher strength steel would offer greater ballistic protection. However, because a new mode of fracture intervenes -- adiabatic shear -- the higher strength steel can be penetrated with a lower velocity for the example shown.

The level of understanding of the dynamic tensile mode of fracture is superior to that of shear failure. This is unfortunate because the latter is by far the more common in both armor/penetrator interaction and fragmentation munitions.

Recognition of the importance of shear bands to ordnance applications date from World War II; at that time a possible explanation for their occurrence was competition between work-hardening and thermal-softening. The idea was that the initial result of plastic work is an increase in flow stress (the material work-hardens). However, most of the work is converted to heat, and, because there is insufficient time for thermal flow, a thermal-softening effect competes with work-hardening effects as plastic deformation continues. If thermal softening wins locally, further deformation is concentrated in local regions, and localized failure patterns are observed.

Until recently no attempt has been made to quantify the early shear fracture model largely because no analytical model was able to provide sufficient details. Such computer codes as HEMP, however, have renewed interest in modeling the adiabatic shear fracture process.

One such model is outlined below. The idea is to make the flow stress of the material depend upon both plastic strain γ^p and temperature T as in the expression

$$Y = Y_0\ (1 + \beta\gamma^p)^n \exp(-aT/(Tm-T))$$

The effective plastic strain γ^p can be computed instantaneously at each finite difference mesh point. Furthermore, the plastic work effected by a stress state σ_{ij} acting through a strain $d\epsilon_{ij}^p$ is

$$\Delta W = S_{ij} \cdot d\epsilon_{ij}^p$$

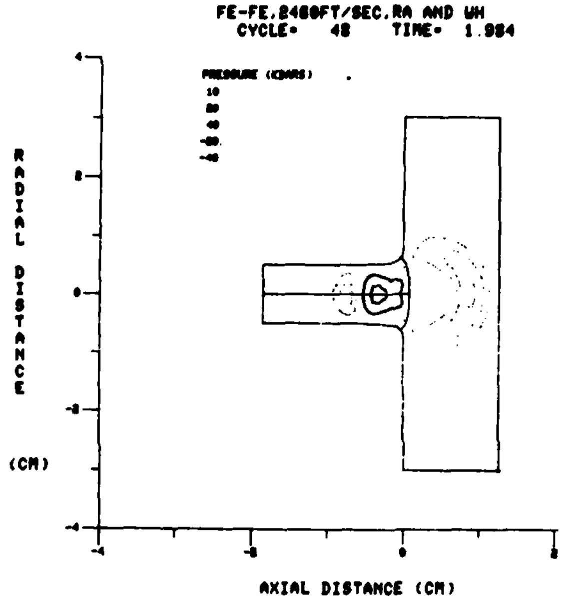

Figure 11. Computer Simulation of a Cylinder Interacting with a Target 2 Microseconds after Impact

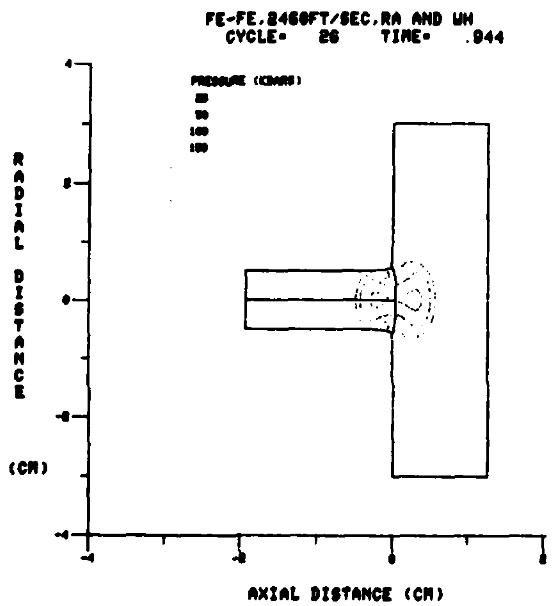

Figure 10. Computer Simulation of a Cylinder Interacting with a Target 1 Microsecond after Impact

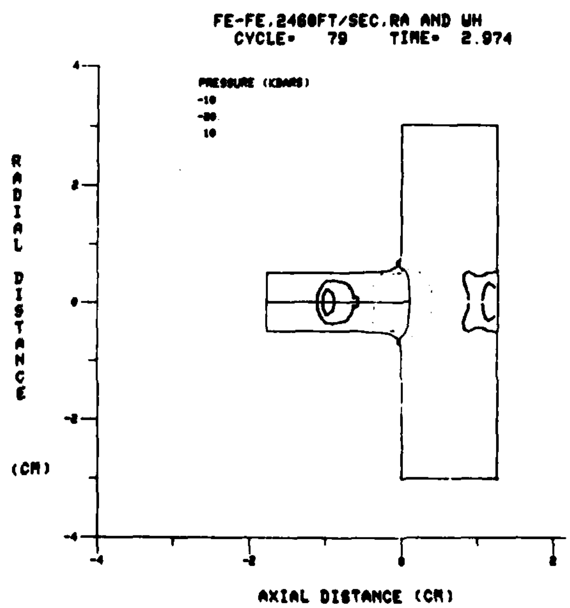

Figure 12. Computer Simulation of a Cylinder Interacting with a Target 3 Microseconds after Impact

S_{ij} is the deviatoric component of total stress. The associated temperature rise is given by

$$\Delta T = k\Delta W/\rho C_V$$

where ρ is the material density and C_V the specific heat.

The quantity in the first parentheses for the expression for flow stress Y represents the work hardening contribution; the second represents thermal softening.

Two practical problems arise with this model. First, it relies on explicit knowledge of the dependence of flow stress on temperature; such data are not readily available and are expensive to generate. Second, data for both work-hardening and thermal-softening are generally obtained under isothermal, not adiabatic, conditions.

An improvement in this model has recently been suggested; the Olson model derives an analytical expression for stress-strain behavior under adiabatic conditions. It results in the expression

$$Y = Y_0 \ (1+\alpha\epsilon^p) \ \exp(-\beta\epsilon^p)$$

It is similar to the prior model but has several advantages. The first is that it is expressed solely in terms of the plastic strain level ϵ^p; thermal-softening effects are in the exponential terms. This model exhibits a characteristic instability strain; i.e. a value of strain for which $dY/d\epsilon^p = 0$, and the flow curve reaches a maximum and begins to decrease as deformation proceeds. This form of the Olson model estimates that plastic instability begins at a strain of

$$\epsilon_i = (\alpha-\beta)/\alpha\beta$$

Experimental evidence that such behavior does in fact exist can be found in results of dynamic torsion tests; when such tests are done under sufficiently high nominal strain rates, adiabatic conditions might be expected to persist. In particular, results on a high-strength steel (H4-TUFF) and on mild steel (1018) exhibit the behavior cited and provide estimates for the parameters of the Olson model.

To test the suitability of such models for simulating the behavior of steels under ballistic impact conditions, computer simulations were run in which the same projectile struck a hard and a soft steel. The designations hard and soft refer to values of flow stress used in the calculations as determined by the experimental data fitted to the Olson model.

Computer simulations provided the gross features of the experimental results. For an impact velocity below the penetration limit, the soft target had a large crater at the impact site and a large bulge at the rear. The hard target had a small crater at the impact site and no perceptible bulge at the rear.

More significant is that the softer target showed no tendency toward adiabatic shear localization -- material near the impact site was moved gradually out of the region by massive plastic flow. In fact, all the target material continued to work-harden.

By way of contract, on the hard target a few zones immediately in front of and near the outer perimeter of the projectile had begun to thermally soften, to decrease in strength after a plastic instability had begun. However, for the impact conditions studied to date, no dramatic localization or propagation of this behavior has been observed in the calculations.

Although these results are somewhat tentative, particularly since the data used in the calculations do not correspond precisely to those appropriate for materials for which ballistic experimental data are available, they are nonetheless encouraging and appear to produce far better simulations than do the same calculations with simpler material property descriptions.

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LITERATURE REVIEW

survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains an article about cross-flow-induced instabilities of circular cylinders.

Dr. S.S. Chen, of the Argonne National Laboratory, has written a paper that reviews dynamic instability of circular cylinder arrays subjected to cross flow. Instability mechanisms, different types of instability, mathematical models, empirical correlations for the critical flow velocity, and effects of various system parameters are discussed.

CROSS-FLOW-INDUCED INSTABILITIES OF CIRCULAR CYLINDERS

S.S. Chen*

***Abstract** - Dynamic instability of circular cylinder arrays subjected to cross flow is reviewed. Instability mechanisms, different types of instability, mathematical models, empirical correlations for the critical flow velocity, and effects of various system parameters are discussed.*

The state of the art of flow-induced vibrations of circular cylinders was presented in a previous review [1, 2]. Analytical methods; classification of structural response; vibration in stationary fluid, parallel flow, and cross flow; design considerations; and research needs were considered. Significant progress has been made toward understanding the complex phenomenon of cylinder/flow interaction, in particular, circular cylinders subjected to cross flow.

It is generally conceded that there are four basic flow excitation mechanisms in cross flow: fluidelastic mechanism, vortex shedding, turbulence buffeting, and acoustic excitation. Depending on the situation, more than one of the four mechanisms can be active in a structural system.

Various mathematical models have been developed to predict structural response to different excitation sources. From a practical point of view, it is of interest to quantify the parameters involved in large displacements (instability) or the structural response at subcritical flow velocity ranges. Let structural displacements be defined as a column vector (q); $(\dot{q})$ and $(\ddot{q})$ are the structural velocity and acceleration respectively. The dynamic structure/fluid interaction is described by the following equation [3].

$$[M_s + M_f]\ (\ddot{q}) + [C_s + C_f + C_r + C_v]\ (\dot{q}) + [K_s + K_f]\ (q) = (Q_s) + (Q_v) + (Q_t) + (Q_o) \tag{1}$$

where

$[M_s]$ = structural mass
$[M_f]$ = added mass of fluid
$[C_s]$ = viscous damping of structure
$[C_f]$ = viscous damping of fluid
$[C_r]$ = radiation damping of fluid
$[C_v]$ = velocity-dependent damping of fluid
$[K_s]$ = structural stiffness
$[K_f]$ = fluidelastic stiffness
Q_s = steady fluid force
Q_v = vortex excitation force
Q_t = turbulence buffeting force
Q_o = other excitations

In general, fluid forces are functions of q, $\dot{q}$, and $\ddot{q}$, and a complete solution is therefore difficult. Fortunately, in many practical situations, all nonlinear terms can be ignored such that M_f, C_f, C_r, C_v, K_f, Q_s, Q_v, Q_t, and Q_o are independent of structural motion. Solution of equation (1) will provide either the instability threshold or the response of the structure. The solution procedures are straightforward for linearized equations. This review focuses on the fluidelastic mechanism.

DYNAMIC INSTABILITY

A structure submerged in a flowing medium will be subjected to such flow excitation forces as turbulence buffeting and wake force due to vortex shedding. These forces act on the structure even if it is stationary. When the structure is elastic, additional fluid forces become important. They are functions of structural motion and include fluid inertia force $[M](\ddot{q})$, fluid damping force $[C_f + C_r + C_v](\dot{q})$, and fluidelastic force $[K_f](q)$. Each force appears on the left side of the equation of motion; the phenomena attributed to these forces are classified as the fluidelastic mechanism.

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For circular cylinders three types of dynamic instability across a flowing medium have been discussed in the literature: wake-induced flutter [4-15], jet-switching instability [15, 16], and fluidelastic instability of cylinder arrays [17-53]. Other types of instability -- galloping of non-circular cylinders and flutter of suspension bridge decks -- are not included in this review.

Wake-induced flutter occurs when more than one cylinder is present; for example, consider twin cylinders with one behind the other in a flow stream. The wake behind the upstream cylinder contains periodicities and general turbulence. When this wake strikes the downstream cylinder, large oscillations can be excited in the cylinder; this motion moves downstream near the outer edge of the wake and upstream near the wake center. This is called wake-induced flutter, wake galloping, or wake-induced oscillation. Wake-induced flutter has been observed with two, three, four, or more conductor arrangements. Because the oscillation can be wholly within a subspan bound by the conductor spacers, it is also referred to as a subspan oscillation.

When a stream flows across a closely spaced cylinder row, a series of similarly sized and spaced jets appears in the wake (see Figure 1). These jets pass downstream of the cylinders and coalesce in pairs. If the cylinders oscillate, they can cause the jets to switch back and forth, forming different pairs; the drag forces acting on the cylinders will vary significantly. Cylinder motions and jet switching are thus coupled, and large oscillations of the cylinder can occur.

When one cylinder in an array in a cross flow is displaced from its equilibrium position, fluid forces exerted on the cylinder change. If the variation in fluid forces is sufficiently large, large oscillations of the cylinder can occur. This type of motion is called fluidelastic instability, which has also been described as fluidelastic vibration, fluidelastic orbital vibration, fluidelastic whirling, whirling instability, aeroelastic coupling, and hydroelastic instability.

MATHEMATICAL MODELS AND INSTABILITY MECHANISMS

The equations of motion for different cylinder arrays can be reduced to the matrix form of equation (1). However, depending on the situation and the type of instability, the coefficient matrices will depend on different parameters.

The mathematical models for wake-induced flutter are commonly based on two cylinders. Different forms of fluid forces acting on cylinders have been proposed [10, 13-15]. A summary of these models is given in the Table. The models have been developed for cylinders oscillating in air; therefore, the added mass of fluid is neglected. Fluid damping and fluidelastic forces are derived from the drag and lift forces.

The critical flow velocity can be predicted using quasi-steady linear theory. In the analysis, it is necessary to have complete force data for the downstream cylinder. Some force measurements are available, but the data are restricted to the case that the upstream cylinder is stationary. Drag and lift force coefficients for the case in which both cylinders are moving are not available.

Roberts [16] studied the low frequency jet-switching instability of a cylinder row using a single-degree-of-freedom system. He assumed that alternate cylinders move with equal amplitude, frequency, and phase and that the remaining cylinders are fixed. The equation is simplified and examined for stability by the method of Kryloff and Bogolinhoff.

The jet-switching mechanism requires a finite time for entrainment of fluid by the jets. Jet switching usually occurs at a highly specialized set of circumferences and will not occur for reduced flow velocity V less than 75. ($V = U/fD$; U = flow velocity, f = cylinder natural frequency, and D = cylinder diameter.)

The threshold flow velocity for fluidelastic instability of cylinder rows was originally developed by Connors [17].

$$\frac{U}{fD} = k\left(\frac{2\pi\zeta M}{\rho D^2}\right)^{0.5} \tag{2}$$

In equation (2) ζ = cylinder modal damping ratio, ρ = fluid density, M = effective mass per unit length (cylinder mass plus added mass), and k is an empirical constant. Equation (2) was derived by equating the energy per cycle that the fluidelastic mechanism adds to a cylinder vibrating in the flow stream and the energy dissipated per cycle by damping. Connors

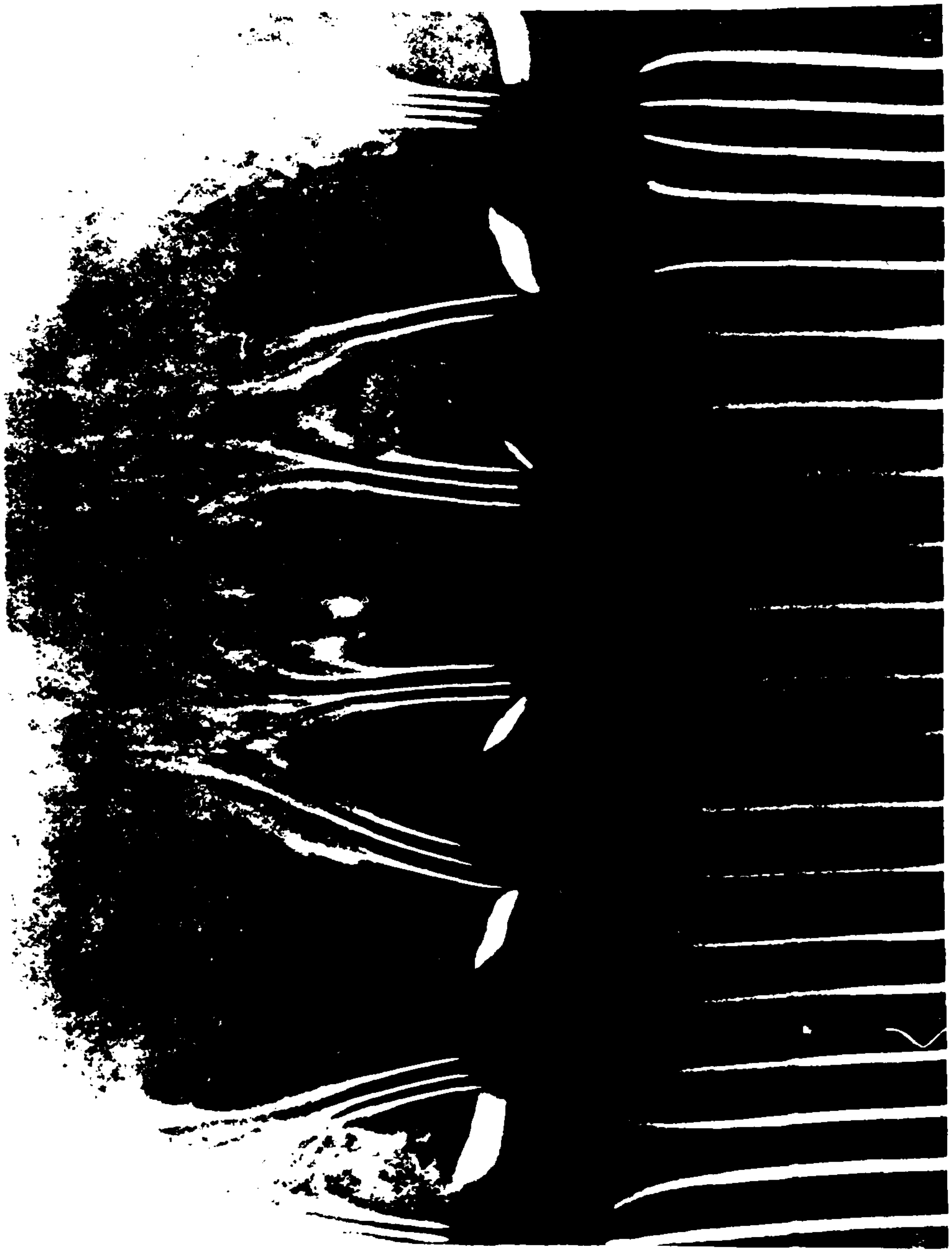

Figure 1. Jets behind a Row of Circular Cylinders [16]

Comparison of Four Mathematical Models for the Fluid Dynamic Forces on Tandem Conductors in Motion [13]

	Tsui & Tsui Model [13]	Hardy Model [14]	Rawlins Model [15]	Simpson-Flower Model [10]
Is the effect of the motion of the upstream conductor on the wake velocity distribution taken into account?	No	Yes	Yes	Yes
Is the time lag between these two conductors experiencing fluid dynamic forces taken into account?	No	No	No	Yes, but in very complicated way
Are the lift and the drag coefficient of the upstream conductor required?	No, Lift coefficient $C_L = 0$ Drag coefficient $C_D = 0$	No, $C_D = 1.2$ for laminar flow $C_D = 0.8$ for turbulent flow $C_L = 0$	Yes	Yes
Is the variation of the lift and drag coefficients with respect to the flow velocity taken into account?	No	No	Yes	Yes
Does the model provide means to include the buoyancy force?	No	No	No	Yes
Fluid dynamic forces on the upstream conductor	Linearized fluid dynamic force	Same as Tsui-Tsui model	Differs from Hardy model because of (1) Lift and drag coefficients of the upstream conductor (2) Derivatives of the above lift and drag coefficient with respect to flow velocity.	Same as Rawlins model
Fluid dynamic forces on the downstream conductor	Linearized fluid dynamic force	The only differences between Hardy and Tsui & Tsui model are fluid dynamically cross damping terms attributed to the velocity of the upstream conductor	The difference between this model and Hardy's is caused by the derivatives of fluid dynamic coefficients with respect to the flow velocity	The difference between Simpson's and Rawlin's lies in at least two aspects: 1) the time lag 2) the buoyancy force

later applied equation (1) to cylinder arrays with different values of k [45]. This model implicitly includes the terms M_s, C_s, C_f, K_s, and K_f. Because flow-velocity-dependent damping is not considered, the instability is caused by the fluidelastic force, and K_f is the key matrix in determining the threshold of instability in a given system.

The model developed by Connors was formally put in the form of the equations of motion by Blevins [21], who included some of the elements of the fluidelastic stiffness matrix $[K_f]$. The threshold flow velocity was analyzed using the experimentally observed mode shape. Frequency and damping variations among tube arrays were considered in the analysis. A control volume momentum analysis was later used to obtain some of the elements in the fluidelastic stiffness matrix [43]. Damping is assumed to be that in the stationary fluid; i.e. no flow-velocity-dependent damping is considered. Blevins [49] recently incorporated flow-velocity-dependent damping in the model; he assumed that it is a linear function of flow velocity. In these analyses, the instability is attributed to a fluidelastic force ($K_f q$).

Chen [3, 41] derived the equations of motion for cylinder arrays as given in equation (1) including inertia coupling due to fluid, flow velocity-dependent damping, and fluidelastic forces. After these forces are known, the model can be used to calculate natural frequencies and mode shapes of fluid-cylinder coupled modes, critical flow velocities and instability modes, and responses to other excitation sources. Based on this model, instability can be caused by fluidelastic forces, flow-velocity-dependent forces, or a combinatioı f both. Depending on the situation, the system might be subjected to different types of instability, so that multiple instability flow velocities occur. Experimental data obtained by Connors [17] for a tube row with a pitch ratio of 1.42 was used with the model to predict most of the features of flow-tube interactions observed experimentally [41].

Balsa [34] used the potential flow theory to derive an expression for the fluid forces acting on cylinder arrays. He found that, in most cases, instability is a direct result of fluidelastic force ($K_f q$) and that the mechanism is a negative spring stiffness associated with the fluidelastic effect. The stability criterion is obtained by equating the stabilizing elastic stiffness of the structure to the destabilizing fluid dynamic self-stiffness. Note that this is a divergent type of instability with zero frequency.

Savkar [37] proposed an empirical design correlation based on Connors' model; he determined the stability constant k from the potential flow arguments leading to negative stiffness, similar to Balsa's [34] results. The constant k was found to be a function of the transverse pitch ratio and two elements of the fluidelastic stiffness matrix. Again, the mechanism in this model is attributed only to the fluidelastic force [$K_f q$]. Savkar pointed out the inadequacy of the quasi-static theory and stressed the need for a mathematical description of dynamic instability [37, 42].

In tests of tube arrays, Gross [26] observed different instability modes for in-line and out-of-line arrays. He concluded that the oscillations predominantly in the lift direction for in-line arrays are associated with the galloping phenomenon. The instability mechanism is thus attributed to a flow-velocity-dependent force ($C_v \dot{q}$). The instability for out-of-line arrays, however, is associated with the coupling of neighboring tubes; Gross called the relationship aeroelastic coupling [26].

The mechanisms of dynamic instability of cylinder arrays are not yet fully understood. However, all types of instability observed experimentally can be classified as dynamic instability. The key parameters in equation (1) are C_v and K_f. Note that C_v is a function of U; K_f is a function of U^2. Based on equation (1), some general conclusions can be made:

- Dynamic instability of cylinder arrays can be caused by either fluidelastic force ($K_f q$), flow-velocity-dependent force ($C_v \dot{q}$) or a combination
- Divergence (static instability) has not been observed experimentally. Whether divergence can occur in cylinder arrays depends on the characteristics of K_f
- Using the damping values measured in stationary fluid is equivalent to neglecting the flow-velocity-dependent force. If flow-velocity-dependent force is important, neglecting it can lead to erroneous conclusions
- A single elastic cylinder among a group of rigid cylinder arrays loses stability if it becomes dynamically unstable [46]. The relative motion pattern [17, 26] is not a necessary condition for dynamic instability induced by a flow-velocity-dependent force
- When the tube spacing becomes large, the fluidelastic matrice becomes small, and dynamic instability will not occur

On the basis of the fluidelastic force ($K_f q$) and the flow-velocity-dependent force ($C_v \dot{q}$), the various terms used in the literature to describe dynamic instability can be grouped as follows:

- Instability induced by fluidelastic force: fluidelastic instability, fluidelastic vibration, fluidelastic orbital vibration, whirling instability, fluidelastic whirling, aeroelastic coupling, and hydroelastic instability
- Instability induced by flow-velocity-dependent force: jet switching of cylinder rows and galloping of cylinder arrays
- Instability induced by a combination of fluidelastic and flow-velocity-dependent force: wake-induced flutter, wake-induced oscillation, wake galloping, and flutter of cylinder array

Additional descriptive terms will doubtless appear in the literature. If the precise mechanism is not specified, however, it is sometimes difficult to understand the meaning of each term.

In summary, future development of the mathematical model can be accomplished using equation (1). The two key parameters are the matrices C_v and K_f. A systematic experimental/analytical program is definitely needed to obtain these matrices for practical flow conditions and cylinder arrangements. The main problem is to quantify these parameters from flow field measurements and analysis of the flow field.

EMPIRICAL CORRELATIONS FOR THE THRESHOLD FLOW VELOCITY OF INSTABILITY

The lowest flow velocity for the onset of dynamic instability is of practical significance. Connors developed the correlation of a cylinder row with a pitch ratio of 1.42 as given in equation (2) with k = 9.9. This correlation can be applied to cylinder arrays with different values of k. Many investigators have conducted experiments in air, water, and two-phase flows to determine the value of k. The available experimental data up to 1976 has been summarized [29].

It is generally accepted that the exponent in equation (2) is 0.5. In an experiment in wind tunnel for an out-of-line triangular array, however, Weaver and Grover [46] obtained the following correlation for the fluidelastic instability boundary.

$$\frac{U}{fD} = 7.1 \left(\frac{2\pi\zeta M}{\rho D^2}\right)^{0.21} \tag{3}$$

Damping values were carefully controlled and systematically varied. (In most tests damping is not controlled.)

In a series of experiments on tube arrays subjected to water flow a generalized correlation was used [47, 51].

$$\frac{U}{fD} = k \left(\frac{2\pi\zeta M}{\rho D^2}\right)^{\alpha} \tag{4}$$

The values of k and α vary widely; α varies from 0.03 to 1.08 and k from 2.49 to 6.03. Available data [26, 46, 47, 51] was used to summarize the results (see Figure 2). A least-square fitting of all experimental data is

$$\frac{U}{fD} = 4.51 \left(\frac{2\pi\zeta M}{\rho D^2}\right)^{0.52} \tag{5}$$

Equation (5) is given by the solid line in Figure 2. Assuming the same functional form and value of exponent, the lower bound of the data is given by

$$\frac{U}{fD} = 2.31 \left(\frac{2\pi\zeta M}{\rho D^2}\right)^{0.52} \tag{6}$$

Equation (6) is represented by the dotted line in Figure 2.

A different approach has also been employed to explain fluidelastic instability [30]. Three factors were considered important for fluidelastic instability to occur: a high Reynolds number R, a low Strouhal number S, and a low transverse tube spacing ratio x_t. A correlation was initially proposed.

$$\frac{R}{Sx_t} = 0.35 \times 10^6 \left(\frac{2\pi\zeta M}{\rho D^2}\right)^{0.5} \tag{7}$$

This correlation was later modified using additional experimental data [35].

$$\frac{R^{0.25}}{S} = \beta \left(\frac{2\pi\zeta M}{\rho D^2}\right)^{0.5} \tag{8}$$

β is a constant. This equation can be reduced to the original correlation developed by Connors [17] assuming that

$$k = \beta R^{-0.25} \tag{9}$$

Based on the galloping mechanism, Gross [26] obtained a stability criterion for cylinder array.

$$\frac{U}{fD} = \frac{4}{K} \left(\frac{2\pi\zeta M}{\rho D^2}\right) \tag{10}$$

K is a constant determined from fluid forces. Equation (10) is similar to that for a single cylinder with a non-circular section.

Even though different expressions have been proposed for the constant k in equation (4) and different values of α for different mechanisms, the correlation given in equation (4) is presently considered to be basically sound and applicable to different mechanisms. Future studies may provide more detailed information on the values of k and α as functions of various system parameters and instability mechanisms.

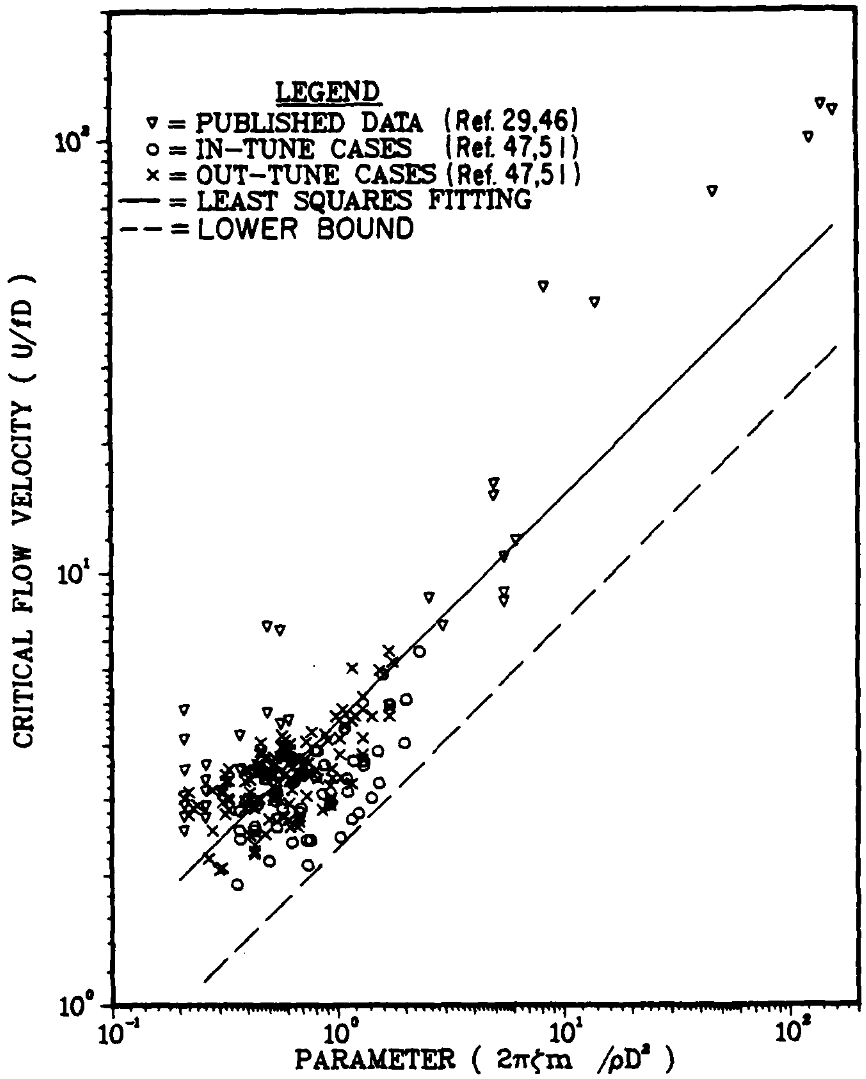

Figure 2. Stability Diagram for Circular Cylinder Arrays

EFFECTS OF VARIOUS PARAMETERS

The parameters considered include cylinder arrange ment, detuning, turbulence, partial admission, type of fluid, and damping.

Cylinder arrangements. Various circular cylinder arrangements are given in Figure 3. The threshold flow velocity for the onset of instability depends on the cylinder arrangement.

Soper [54] conducted a series of tests to determine the effect of cylinder arrangement: in the practical range of pitch ratio, in-line arrays are more suscepti- ble to dynamic instability and rectangular arrays are more stable. However, the results are not in complete agreement with those obtained by Hartlen [22]; his data show that triangular arrays are more stable.

The results obtained by Soper [54] have been verified by other investigators. The mathematical models developed by Blevins [43] and Chen and Lin [39] show that in-line arrays are less stable than out-of-line arrays. Gorman [27, 28] has also found that the critical flow velocity for out-of-line arrays are higher than the corresponding in-line arrays.

For out-of-line arrays, the critical flow velocity increases with pitch ratio; however, for in-line arrays, the critical flow velocity is almost independent of pitch ratio in practical ranges of spacing. The critical flow velocity is minimum when the pitch ratio is about 1.5 [26].

Detuning. Detuning is defined as the frequency difference among different cylinders in an array in vacuum. After the array is submerged in fluid, all cylinders are coupled by the fluid. Although theoretical results [21, 41] show that detuning tends to stabilize cylinder arrays, experimental data are not in agreement.

Southworth and Zdravkovich [25] conducted tube row tests with all tubes flexible, three adjacent tubes flexible, alternative tubes flexible, and only one tube flexible. At a given flow velocity, tube response is

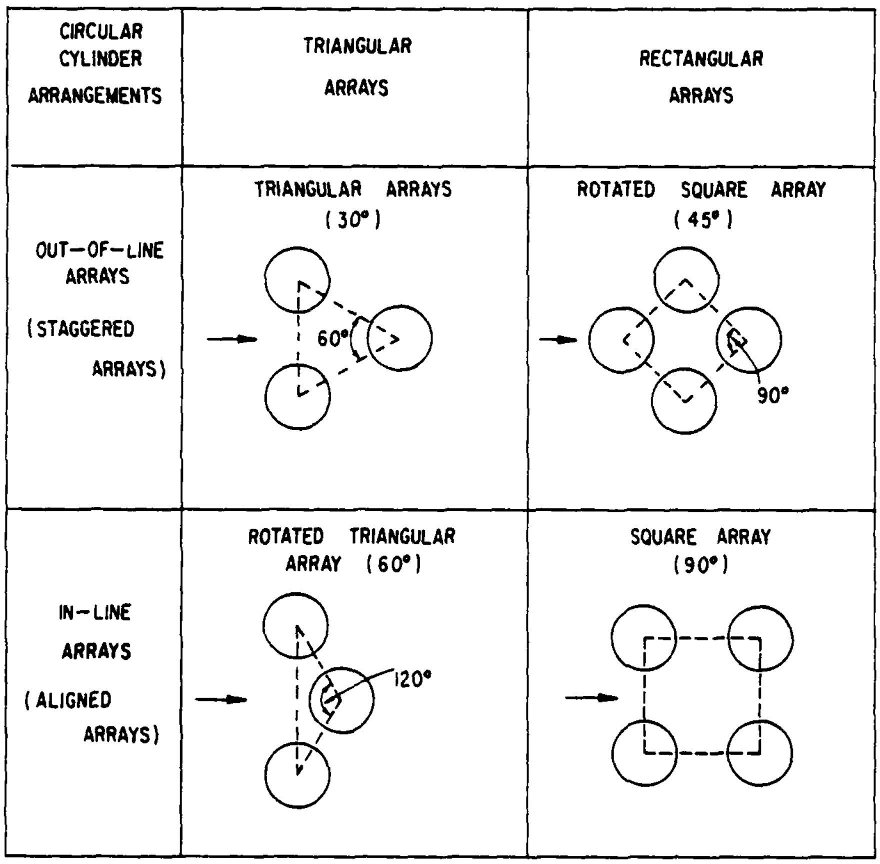

Figure 3. Arrangement of Circular Cylinder Arrays

largest for all tubes flexible and smallest for one tube flexible. This illustrates that detuning tends to stabilize the system. Tests with double tube rows show similar results.

Other experimental data [26, 47, 51] are basically in agreement with those of Southworth and Zdravkovich [25]. Experimental data of critical flow velocity for in-tune and out-of-tune arrays for different amounts of detuning given in Figure 2 show that out-of-tune arrays usually have a higher critical flow velocity [47, 51].

Tests on in-line triangular array [36] have shown that 3% differences in frequency could produce an increase in critical flow velocity of up to 46%. Frequency differences greater than about 10%, however, have no significant effect on critical flow velocity.

It is possible that detuning might cause the critical mode with the lowest critical flow to change to some other mode. Thus, detuning could become ineffective in stabilizing the system. (For a particular mode, detuning is expected to be beneficial in stabilizing the cylinder system.)

Turbulence. Upstream turbulence can affect critical flow velocity. Wind tunnel experiments [24, 26] have shown that turbulence produces a shift in the initiation of fluidelastic instability to higher flow velocities. However, other wind tunnel experiments [38] have shown that turbulence tends to reduce the critical flow velocity. A water tunnel has been used to resolve the discrepancy [51]; turbulence can stabilize or destabilize the cylinder array, depending on the characteristics of the turbulence. In general, upstream turbulence tends to stabilize the system. This hypothesis is supported by the observation that the downstream tubes, which are subjected to higher turbulence level, usually lose stability at a higher flow velocity. The decrease of critical flow velocity in the experiment by Franklin and Soper [38] is probably attributable to the specific turbulence generated by the grid very close to the test section.

Partial admission. Empirical correlations have been developed for the case in which the entire length of cylinders is subjected to flow perpendicular to the cylinder axis. In many structural components or experiments, only part of a cylinder array is subjected to flow. A general practice is to reduce the general case of nonuniform flow with cylinder arrays partially submerged in flow to the ideal case of uniform flow with cylinder arrays completely submerged in flow. Assume that the flow velocity for the general case is u(z). An equivalent uniform flow velocity is defined by

$$U^2 = \frac{\int_{\text{length in flow}} \phi^2(z)dz}{\int_{\text{total length}} \phi^2(z)dz} \qquad (11)$$

where $\phi(z)$ is a modal function under consideration [38, 45, 47]. This approach is satisfactory in many practical situations. However, it sometimes is difficult to determine the critical mode. For example, the second mode [48] and the eighth mode [44] have been found to be critical. It is thus necessary to evaluate the critical flow velocity for most of the lower modes.

The development of equation (11) is based on the assumption that no flow-velocity-dependent force exists. Obviously, this assumption is not generally valid. A more rigorous analysis will require the solution of the complete coupled equation of motion, equation (1).

Types of fluid. Cylinder responses in liquid, gas, and two-phase flows are not the same. In liquids, the upstream cylinder row is usually the critical one. Experiments in water [28, 32, 47, 51] have shown that the upstream cylinders are most susceptible to instability. The concept of a prison bar in the upstream has been proposed [19] on the basis of this observation.

Cylinder responses in gas flow have been investigated [26] for different pitch ratios. For in-line arrays, the first three rows in the upstream might be the critical ones; for out-of-line arrays, the first two rows might lose stability at the lowest flow velocity. The critical cylinder row is shifted in the direction of flow as the pitch ratio becomes larger.

Little work has been reported for two-phase flow. Pettigrew and Gorman [18] conducted an experiment in a simulated two-phase flow. Their main results are as follows: upstream cylinders vibrate most; vibration amplitudes are maximum at roughly

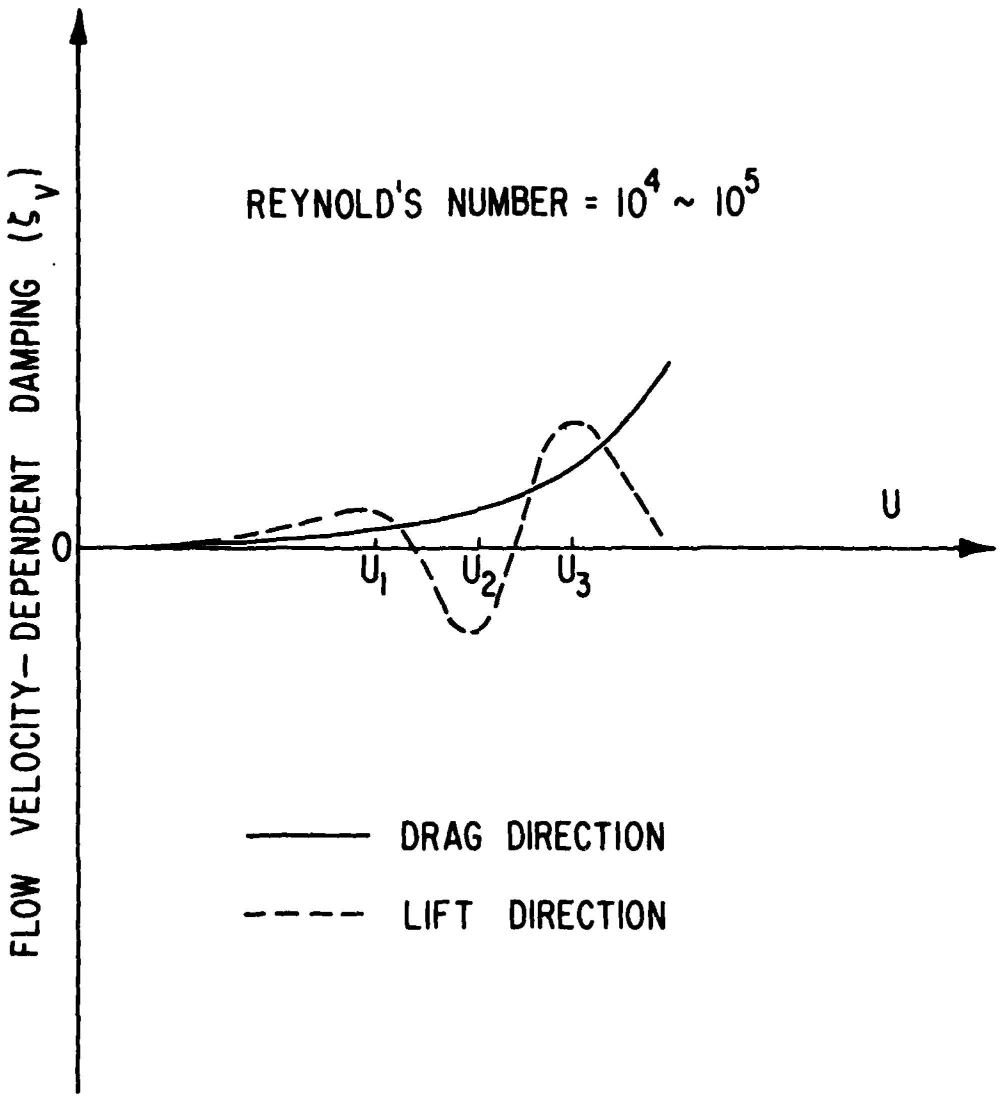

Figure 4. General Trends of Flow Velocity-Dependent Damping for Cylinder Arrays [40]

15% steam quality; in-line rectangular array vibrates most; vibration amplitude is generally larger in the drag direction than in the lift direction.

Damping. Damping is commonly measured in stationary fluid. However, theoretical and experimental results show that fluid damping depends on flow velocity. In a study of cylinder arrays, Chen [3] derives a form of flow-velocity-dependent damping that includes cross coupling. Blevins has also proposed taking the flow-velocity dependent damping into account [49].

Little experimental data is available for flow-velocity-dependent damping in cylinder arrays subjected to cross flow. The diagonal terms of the damping matrix (self-damping) for two cylinder arrays have been studied [40]. Among the conclusions are: damping in the lift direction can increase or decrease with flow velocity but increases in the drag direction with flow velocity; fluid damping depends on cylinder location in an array; flow-velocity-dependent damping can be negative; fluid damping varies drastically when vortex shedding occurs or instability of a cylinder array develops, in particular, damping in the lift direction changes more drastically. Experimental results were used to determine the general trends of the flow velocity-dependent damping given in Figure 4 in the drag and lift directions; ζ_v is the modal damping ratio attributed to flow velocity. In general, in Figure 4, U_1 corresponds to the beginning of synchronization of vortex shedding with cylinder natural frequency; U_2 corresponds to the coincidence of vortex shedding and cylinder natural frequencies; and U_3 corresponds to the decrease of damping in the lift direction.

CONCLUDING REMARKS

Fluid flowing across cylinder arrays can result in excessive vibration or instability. The problem has become evident in recent years as flow rates have increased; a significant increase in the incidence of damage to system components has occurred.

In the past decade, model tests have generally been used to obtain design data. The tests required for any new design are very costly and time consuming. The main problem is that reliable analytical methods are still not available to analyze system responses under different conditions.

Difficulty is in the characterization of the fluid field and its interaction with cylinder motion. Efforts have been made to quantify fluid effects: Mirza and Gorman [19] measured the fluid force acting on a cylinder in an array; Zdravkovich and Namork [52] investigated the fluid field around a cylinder in an array in a wind tunnel; Chen and Jendrzejczyk [40] studied the flow-velocity-dependent force in water flow. Mathematically, these efforts correspond to the matrices given in equation (1): M_f, C_v, and K_f. In most cases, M_f can be calculated according to the potential flow solution, although the effect of flow separation on M_f warrants further study [55]. Therefore, the main task is to obtain C_v and K_f for various cylinder arrays. Significant progress has been made, both in analysis and experiment, by investigators around the world. It is expected that a better understanding of the phenomena can be achieved in the near future.

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BOOK REVIEWS

ACOUSTICAL ENCLOSURES AND BARRIERS

R.K. Miller and W.V. Montone
The Fairmount Press, 1978

This is a small, useful text in the form of a handbook for practitioners. The 250 pages are divided into 12 chapters: The Role of Enclosures in Industry, Acoustical Material Rating Systems, Materials for Special Environments, The Acoustical Wall, Employee Enclosures, Machine Enclosures, The Acoustical Skin, Enclosure Ventilation, Barriers, Economic Assessment of Enclosure Systems, Commercially Available Acoustical Enclosures, and Acoustical Performance Data. Two short Appendices give noise control terminology and conversion factors.

Emphasis throughout is on the design information and theoretical formulas needed by working engineers or designers in this acoustics field. The treatment is pointed and compressed. Numerous practical design forms are suggested. Little of an academic or didactic nature is found in the text (for example, formulas are not derived from basic principles), but the sources of most formulas and advanced theoretical material are given in references at the end of each chapter.

The text in its present form can be utilized by serious designers without special acoustical training and can serve as a handy compendium of recent practical considerations for those with some experience in the field. The authors do state, however, that they base the text upon an expected common level of understanding in the acoustics field.

The authors' extensive practical experience in dealing with industrial problems of the type cited emerges in the text, which should find considerable successful application.

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WAVES IN FLUIDS

James Lighthill
Cambridge University Press
Cambridge, U.K., 1978

Lighthill holds a most prestigious chair in Applied Mathematics, but the reader would never know it from his deliberate avoidance of advanced mathematics whenever possible. In the first half ot the book, which deals with acoustics, I found only one special function -- a harmless Bessel function at that!

The author assumes that the reader is acquainted with undergraduate mathematics, fluid mechanics, and thermodynamics. The book relies more extensively than is customary on non-mathematical, verbal formulations. Elegantly written and lucid in style the book appeals to logic and common experince. Lighthill even cites a poem by Frost that beautifully describes stationary gravity waves in a brook.

As I read the two acoustics chapters, I envied the students for whom this would be a first exposure to the field. Even though I have been active in acoustics for almost three decades, I gained new insight into some familiar problems. The simplicity of Riemann's nonlinear theory of sound waves is unsurpassed. In addition to subjects traditionally covered in textbooks on acoustics, Lighthill dwells extensively on cardiovascular situations. The derivation of Lighthill's eighth power law of turbulence-radiated acoustic power is, as might be expected, masterly in its clarity.

The second half of the book deals with water waves and internal waves. Even the reader not concerned with these subjects will find certain pages unusually rewarding; e.g., the treatment of group velocity, the method of steepest-descent, caustics, stationary-phase integration in three dimension. The material is presented with minimum mathematical apparatus and emphasizes physical interpretation.

There are inevitably some points that I would have preferred to see handled differently. The discussion of sound propagation in elastic tubes is unnecessarily limited in frequency range by the use of the static tube compliance, without a hint of the effect of the axisymmetric tube wall resonance. The extensive use of ripple tank photographs to illustrate sound fields, while useful in movies, adds little when presented as still photographs.

Even though the book is intended to be a comprehensive introduction, experienced acousticians, whether theoretically inclined or application-oriented, will derive new insight from certain portions. The book is intended as a textbook for college seniors and graduate students. With this purpose in mind, Lighthill has appended an extensive series of problems to each chapter. The book is superb as a textbook, but some instructors might hesitate to have students purchase a text half of which most will not use -- because presumably only a modest percentage of acoustics students is interested in gravity waves, and vice versa.

M.C. Junger
Cambridge Acoustical Assoc. Inc.
54 Rindge Ave. Ext.
Cambridge, MA 02140

THE THEORY OF ELASTIC WAVES AND WAVEGUIDES

J. Miklowitz
Elsevier-North Holland Pub. Co.
Amsterdam, The Netherlands
and New York, NY, 1978

The subject of this book is wave propagation in a linear elastic homogeneous medium. The careful and rigorous treatment is meant to give the reader a basic understanding of the methods of analysis as well as the physics of wave propagation in a linear elastic medium.

The book begins with a historical introduction of the subject of elastic wave propagation and summaries of the topics. They will serve as a useful guide to the interested reader.

Chapter 1 deals with the formulation of the basic equations of linear elastodynamics. In Chapter 2 the fundamental singular solutions of the equations of motion are derived. The author shows decomposition of the solution into dilatational and equivoluminal parts. A discussion of plane waves is followed by the subject of waves generated by spherical and cylindrical sources. Propagation of a surface of discontinuity is followed by the derivation in terms of retarded potentials of the solution of the distributed force problem and a discussion of the method of characteristics.

The reflection and refraction of time-harmonic plane waves at an interface of two elastic media are discussed in Chapter 3. The special case of a single half-space is treated in detail. The generation of Rayleigh and Stoneley waves is also examined.

Chapter 4 deals with vibration of plates and rods and is based on the exact equations. Particular attention is paid to the Rayleigh-Lamb frequency equation and its solution. Love waves in an elastic homogeneous layer overlying an elastic homogeneous half-space is also treated.

Chapter 5 serves as an introduction to integral transforms and asymptotic expansions. These are the mathematical tools needed to solve the transient wave propagation problems in the remaining three chapters of the book. Much of the material in the last three chapters is derived from original work of the author and his co-workers over the last few years. These chapters will serve as valuable references to workers in the field.

Transient waves in a half-space are dealt with in Chapter 6. The Lamb problem is treated in detail, and the problem of a buried line dilatational source is discussed. The power of the Cagniard-de Hoop technique for evaluating the inverse Laplace transform is clearly illustrated in connection with these two problems. The chapter concludes with an abridged version of the work of the author and Gakenheimer on the moving load problem.

Chapter 7 deals with the transient wave propagation in semi-infinite rods and plates (the wave-guide problem) and is a highlight of the book. The author and his co-workers have made valuable contributions, many of which are included. Details of many interesting edge-load problems are given. This chapter makes the book unique among the books available on wave propagation.

Scattering of elastic waves is treated in Chapter 8. The scattering by a half-plane is treated thoroughly, as is diffraction by a circular cylindrical cavity. Recent work on diffraction by a circular elastic cylinder and by a spherical cavity is summarized.

A short guide to recent work serves to extend the problems given in the text. Also included are references to work dealing with such effects as anisotropy, nonhomogeneity, and thermal.

This is a fine text and a valuable reference book. Each chapter contains an extensive bibliography and a valuable set of exercises.

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SHORT COURSES

MAY

SECOND INTERNATIONAL SEMINAR IN PIPING DESIGN AND PIPE STRESS ANALYSIS

Dates: May 12-16, 1980

Place: Texas A&M University

Objective: This seminar addresses engineers, stress analysts, piping designers and others whose daily functions are related to piping design and stress analysis. The seminar aims to keep participants abreast of rapid changes underway in the petrochemical and power industries with a focus on the latest additions, deletions and modifications of related piping codes. Seminar faculty with recognized expertise will discuss basic philosophy and requirements of piping codes, industry design practice and approximate as well as computer methods of static and dynamic analysis. The seminar places practical emphasis on topics in rotating equipment, piping dynamics, high pressure technology, failure prevention and field troubleshooting.

Contact: Dr. M. Henriksen, Seminar Director, Department of Mechanical Engineering, Texas A&M University, College Station, TX 77843 - (713) 845-3723.

ANALYSIS OF USAF ENGINE STRUCTURAL DURABILITY AND DAMAGE TOLERANCE

Dates: May 15-16, 1980

Place: Seattle, Washington

Objective: This program is designed to provide working engineers and their management with the fundamentals of the disciplines required to ensure the structural integrity of turbine engines. The application of these disciplines to the damage tolerance assessment of the F-100 engine will also be discussed.

Contact: AIAA Professional Study Series, Educational Programs, 1290 Avenue of the Americas, New York, NY 10019 - (212) 581-4300, Ext. 225

JUNE

DAMPING AND ISOLATION TREATMENTS FOR NOISE AND VIBRATION CONTROL

Dates: June 2-6, 1980

Place: Madison, Wisconsin

Objective: The use of viscoelastic materials in damping and isolation systems to solve noise and vibration problems will be discussed in this course. Particular emphasis will be placed on the dynamic properties of viscoelastic materials in design procedures to predict their performance when utilized in a number of damping and isolation systems. Basic definitions, measurements, characterizations, and behavior of the dynamic properties of viscoelastic materials will be given first. The performance of the various damping and isolation techniques will then be reviewed. The damping treatments will include both surface (i.e. extensional and shear deformation) and tuned damping devices. Effects of temperature, frequency, and weight penalty will be discussed for each type of damping treatment. Single and compound isolators will also be presented and the effects of various environmental factors on their performance will be discussed.

Contact: Donald E. Baxa, Program Director, Department of Engineering & Applied Science, University of Wisconsin - Extension, 432 North Lake St., Madison, WI 53706 - (608) 262-2061.

FINITE ELEMENTS, A UNIFIED TREATMENT OF STRUCTURAL SYSTEMS - STATICS, DYNAMICS AND STABILITY

Dates: June 2-13, 1980

Place: UCLA

Objective: Designed for structural engineers and analysts in civil, mechanical and aerospace engineering, and university faculty interested in the finite element method of structural analysis for static, dynamic and stability behavior. The presentation constitutes a unified finite element treatment of structural systems that brings together static, dynamic and stability analysis, both in terms of problem formulation and solution. Techniques are explored that are most suitable for solution by a digital computer. Modern computer programs are also discussed.

Contact: *Continuing Education in Engineering and* Mathematics, P.O. Box 24901, UCLA Extension, Los Angeles, CA 90024 - (213) 825-3344/825-1295.

FINITE ELEMENT ANALYSIS

Dates: June 3-6, 1980
Place: Charlottesville, Virginia
Objective: This course is intended to combine an introduction to engineering finite element analysis with a survey of advanced applications. Topics to be covered include solid mechanics, fluid dynamics, and heat transfer. Many engineering examples will be given throughout the course to assist in understanding the material.

Contact: VIBCO Research Inc., P.O. Box 3307, University of Virginia Station, Charlottesville, VA 22903 - (804) 924-3982.

VIBRATION AND STRESS ANALYSIS USING EXPERIMENTAL TECHNIQUES

Dates: June 4-5, 1980
Place: Cincinnati, Ohio
Objective: This seminar will discuss/demonstrate the use of experimental testing methods to identify and solve complex vibration and stress problems. Recent advancements in the test area have provided test engineers and technicians with increased capabilities to acquire, store, and process experimentally obtained data to successfully map the performance and dynamic load data; to determine the dynamic characteristics; and to integrate with analytical modeling techniques for correlation and direction in model development. Both data acquisition and data analysis techniques will be thoroughly discussed and actually demonstrated.

Contact: Mrs. Gayle Lyons, SDRC Seminar Coordinator, Structural Dynamics Research Corporation, 2000 Eastman Drive, Milford, OH 45150 - (513) 576-2594.

BLASTING AND EXPLOSIVES SAFETY TRAINING

Dates: June 4-6, 1980
Place: St. Louis, Missouri
Dates: June 18-20, 1980
Place: Tucson, Arizona
Dates: September 10-12, 1980
Place: Atlantic City, New Jersey
Dates: September 24-26, 1980
Place: Des Moines, Iowa
Dates: October 8-10, 1980
Place: Nashville, Tennessee
Dates: October 22-24, 1980
Place: Casper, Wyoming
Objective: This course is a basic course that teaches safe methods for handling and using commercial explosives. We approach the problems by getting at the reasons for safety rules and regulations. Helps provide blasters and supervisors with a practical understanding of explosives and their use - stressing importance of safety leadership. Familiarizes risk management and safety personnel with safety considerations of explosives products and blasting methods.

Contact: E.I. du Pont de Nemours & Co. (Inc.), Applied Technology Division, Wilmington, DE 19898 - (302) 772-5982/774-6406.

MACHINERY VIBRATION ANALYSIS SEMINARS

Dates: June 17-18, 1980
Place: Oak Brook, Illinois
Dates: July 9-10, 1980
Place: New Orleans, Louisiana
Dates: August 12-13, 1980
Place: Sheraton Inn-Newark Airport, NJ
Dates: October 1-2, 1980
Place: Houston, Texas
Dates: December 9-10, 1980
Place: Atlanta, Georgia
Objective: These two day seminars on machinery vibration analysis will be devoted to the diagnosis and correction of field vibration problems. The material is aimed at field engineers. The sessions will include lectures on the following topics: basic vibrations; critical speeds; resonance; torsional vibrations; instrumentation, including transducers, recorders, analyzers, and plotters; calibration; balancing and vibration control; identification of unbalance, misalignment, bent shafts, looseness, cavitation, and rubs; advanced diagnostic techniques; identification of

defects in gears and antifriction bearings by spectrum analysis; and correction of structural foundation problems.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

MACHINERY VIBRATION ANALYSIS

Dates: June 18-20, 1980
Place: Houston, Texas
Dates: August 26-28, 1980
Place: Las Vegas, Nevada
Dates: December 10-12, 1980
Place: New Orleans, Louisiana
Objective: The course covers causes, effects, detection, and solutions of problems relating to rotating machines. Vibration sources, such as oil and resonant whirl, beats, assembly errors, rotor flexibility, whip, damping, eccentricity, etc. will be discussed. The effect on the overall vibration level due to the interaction of a machine's structure, foundation, and components will be illustrated.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

DYNAMICS OF STRUCTURAL AND MECHANICAL SYSTEMS

Dates: June 23-27, 1980
Place: UCLA
Objective: For engineers interested in the presentation of the area of structural dynamics at an intermediate level with application to aerospace, civil and mechanical engineering. The course presents the area of structural dynamics at an intermediate to advanced level. The subject is treated in a unified manner so as to be equally applicable to aerospace, civil and mechanical engineering problems. The course emphasizes discrete methods, numerical methods and structural modeling for computer-oriented solution of various structural dynamic problems. Some recent developments in the structural dynamic analysis of parametrically excited systems, rotating systems and systems in which fluid-structure dynamic interactions occur are also considered.

Contact: Continuing Education in Engineering and Mathematics, P.O. Box 24901, UCLA Extension, Los Angeles, CA 90024 - (213) 825-3344/825-1295.

MACHINERY VIBRATIONS SEMINAR

Dates: June 24-26, 1980
Place: Mechanical Technology, Inc.
Latham, New York
Objective: To cover the basic aspects of rotor-bearing system dynamics. The course will provide a fundamental understanding of rotating machinery vibrations; an awareness of available tools and techniques for the analysis and diagnosis of rotor vibration problems; and an appreciation of how these techniques are applied to correct vibration problems. Technical personnel who will benefit most from this course are those concerned with the rotor dynamics evaluation of motors, pumps, turbines, compressors, gearing, shafting, couplings, and similar mechanical equipment. The attendee should possess an engineering degree with some understanding of mechanics of materials and vibration theory. Appropriate job functions include machinery designers; and plant, manufacturing, or service engineers.

Contact: Mr. Paul Babson, MTI, 968 Albany-Shaker Rd., Latham, NY 12110 - (518) 785-2371.

ADVANCED DYNAMIC ANALYSIS FOR MODAL TESTING USERS

Dates: June 25-26, 1980
Place: San Diego, California
Dates: July 9-10, 1980
Place: Cincinnati, Ohio
Objective: This seminar has been organized to provide the serious user (advanced and beginner alike) with a complete knowledge of the capabilities and applications of the SDRC Testing Software Package (MODAL, MODAL-PLUS, SABBA and FATIGUE). The emphasis will, therefore, be on advanced software capabilities and their use to solve dynamics problems. Applications will come from the vehicle, construction and mining equipment, and rotating equipment areas; but, will be of general interest to any engineer working in the area of experimental dynamics.

Contact: Mrs. Gayle Lyons, SDRC Seminar Coordinator, Structural Dynamics Research Corp., 2000 Eastman Drive, Milford, OH 45150 - (513) 576-2594.

JULY

INDUSTRIAL PRODUCT NOISE CONTROL

Dates: July 7-11, 1980

Place: Schenectady, New York

Objective: Designed for engineers, designers, environmental health specialists, and managers concerned with noise and vibration control. The course will provide information on the theory, measurement, and economics of noise reduction. It will cover the latest information on the nature of sound and noise control, including noise criteria, airborne sound distribution, vibration control, and noise signature analysis. Other topics include how noise is produced by different types of engineering equipment such as compressors, electric motors, fans, valves, and transformers.

Contact: Graduate Studies and Continuing Education office, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

PLANNING A DIGITAL DATA ACQUISITION AND CONTROL COMPUTER SYSTEM

Dates: July 9-11, 1980

Place: Schenectady, New York

Objective: Will deal with the interconnection of a multitude of devices from sensors to final control elements with ultimate output of system conditions on the man-machine interface devices; the sensing of temperature, pressure, level, flow, speed, weight, torque, vibration and electrical parameters such as: volts, amps, watts, vars, power factor, frequency, and motor load. The flexibility and utilization of data presentation via dynamic, colored graphic and tabular CRT displays will be presented as an optimum man-machine interface. System components/hardware and their interconnection will be discussed in depth. Staging, on-site testing, and as-built documentation will be the final steps in planning a digital acquisition and control computer system.

Contact: Graduate Studies and Continuing Education office, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

FRACTURE MECHANICS I AND ITS APPLICATION TO ENGINEERING DESIGN

Dates: July 14-18, 1980

Place: Schenectady, New York

Objective: Material covered in "Fracture Mechanics I" will benefit anyone in an engineering related position who is concerned with the application of fracture mechanics to the prevention of brittle fracture such as pressure vessels for power generation, malleable iron castings, structural steel fabricated frameworks, and ASME Pressure Vessel code applications. Included are the engineering approach to component failure; failure analysis of pressure vessels; fracture mechanics based toughness criteria in ASME Pressure Vessel code; examples and case histories of code fracture mechanics applications; elastoplastic analysis; computer aids for calculating remaining cyclical life; crack initiation and propagation; life prediction; and non-destructive testing methods and capabilities.

Contact: Graduate Studies and Continuing Education office, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

APPLIED INSTRUMENTATION AND MEASUREMENTS ENGINEERING

Dates: July 14-18, 1980

Place: Schenectady, New York

Objective: Designed for technicians, engineers, and managers involved in the field of instrumentation and measurements. It will present a comprehensive view of the instrumentation system from transducer to readout, including a major emphasis on computer interfacing techniques. Principal topics will include: philosophy of measurements, transducer operating principles and selection criteria, static and dynamic data acquisition systems, occurrence and prevention of noise in measurement systems, data reduction methods, digital techniques, and statistical treatment of data. "Hands-on" lab experience will be offered.

Contact: Graduate Studies and Continuing Education office, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

INTRODUCTION TO THE VIBRATION AND STRESS ANALYSIS OF PRESSURE ACTUATED VALVES FOR GAS COMPRESSORS USING FINITE ELEMENT METHODS

Dates: July 21-22, 1980

Place: Purdue University

Objective: The course content is general to many fluid machinery systems utilizing pressure actuated flexible valves, however, class examples will emphasize small, high-speed, refrigerant compressors. Interest is directed to the development of suitable mathematical models for the prediction of the dynamic motion of the flexible valve during the compressor cycle and the resultant stress field in the valve. Participants should be familiar with the mathematical simulation philosophy for compressors. Extension of the valve modeling to more detailed descriptions compatible with the general compressor simulation will be presented.

Contact: James F. Hamilton, Ray W. Herrick Laboratories, School of Mech. Engrg., Purdue University, West Lafayette, IN 47907.

PROBABILISTIC ANALYSIS OF VIBRATIONS

Dates: July 21-23, 1980
Place: Irvine, California
Objective: Topics include: fundamentals of probability theory; response of one degree of freedom systems; cross correlation and cross spectral density of force and response; several random point forces, random distributed forces; joint acceptance functions; coherence functions and their application; probability distribution of stress, fatigue; statistical energy analysis; applications in aeronautical engineering; applications in mechanical engineering; applications in civil engineering.

Contact: Computation Mechanics, P.O. Box 4174, Irvine, CA 92716

FRACTURE MECHANICS II WITH INDUSTRIAL APPLICATIONS

Dates: July 21-24, 1980
Place: Schenectady, New York
Objective: Designed for engineers with responsibility and management of fracture analysis and prevention. Some knowledge of fracture mechanics is assumed, since this course represents advanced, "state-of-the-art" fracture mechanics as applied in the pressure vessel and piping fields. Major topics are: fundamental concepts; estimation of plastic zone size; "J" integral and methods for estimation; fundamentals and computer applications of finite element methods to notches and cracks; special topics in advanced analytical methods; selected applied industrial problems; metallurgical aspects of high toughness materials; residual stresses; service environment; "state-of-the-art" in testing for use of small specimens; finite element applications; and elasto-plastic fracture toughness - "R" curves.

Contact: Graduate Studies and Continuing Education office, Wells House, 1 Union AVe., Union College, Schenectady, NY 12308 - (518) 370-6288.

COMPUTER WORKSHOP IN EARTHQUAKE AND STRUCTURAL DYNAMICS

Dates: July 28 - August 1, 1980
Place: Schenectady, New York
Objective: This course will cover structural dynamics techniques for both linear and nonlinear many-degree-of-freedom systems. Special emphasis will be given to seismic applications such as NRC requirements. Random vibration methods will be presented, and response spectrum methods for many-degree-of-freedom systems will be given. In addition, a nonlinear dynamics computer program, as well as eigenvalue and sinusoidal analysis programs, wil be available for workshop use. Listings of these programs and relative merits of ANSYS, SAP, and ADINA programs will be discussed. Computer graphics for input generation and output presentation, as well as applications to current technological problems will be given, including earthquake analysis, pipe whip dynamics, shock response of electronic cabinets, fluid-solid interaction, and self-excited vibrations of a multimodal structure. FORTRAN computer programs will be presented for multi-degree-of-freedom systems, and will be applied to tutorial and student generated problems.

Contact: Graduate Studies and Continuing Education office, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

COMPUTER WORKSHOP IN FINITE ELEMENT METHODS OF ANALYSIS FOR STRESS AND OTHER FIELD PROBLEMS

Dates: July 28 - August 1, 1980
Place: Schenectady, New York
Objective: This course will cover finite element techniques for 2D and 3D structural analysis and dynamics . Both 2D and 3D programs, including listings, will be available for student use. Generalization of finite element methods to heat transfer and fluid flow will be given with programs in each discipline. In

addition, incremental loading into the plastic range and finite element methods in fracture mechanics will be presented. Relative merits of ANSYS; SAP, ADINA, and other programs will be discussed, and computer graphics for input generation and output presentation will be given. Applications to current technological problems will include thermal and stress analysis of nuclear vessel nozzle, 3D pipe intersection, turbine blade application, and water mass of nuclear fuel channels. FORTRAN IV computer programs for both 2D and 3D problems will be presented and applied to tutorial and student generated problems.

Contact: Graduate Studies and Continuing Education office, Wells House, 1 Union Ave., Union College, Schenectady, NY 12308 - (518) 370-6288.

FINITE ELEMENT ANALYSIS IN FLUID DYNAMICS

Dates: August 4-8, 1980
Place: Knoxville, Tennessee
Objective: This course is designed to familiarize the engineer/scientist with the basic concepts and practice of finite element methodology; to detail step-by-step numerical solutions for elementary but highly informative ideal flows; to extend these developments to nonlinear problems, building directly upon introductory concepts; to expose the important aspects of the mathematical theory and make detailed comparison to conventional procedures; to expand applications to turbulent and compressible flows over a range of Mach and Reynolds numbers; and to introduce and correlate the newest developments including tensor products, optimal control, constrained optimization.

Contact: Eunice Hinkle, Department of Engineering Science and Mechanics, University of Tennessee, 317 Perkins Hall, Knoxville, TN 37916 - (615) 974-2171.

NOISE ANALYSIS

Dates: August 6-7, 1980
Place: Cincinnati, Ohio
Objective: This seminar will provide engineers concerned with noise analysis and control an introduction to the most current technology in this area. The session will be dedicated to presenting the latest noise analysis procedures, and the various noise control measures which can be employed, primarily related to product noise. Topics discussed will include: physical acoustics, psycho-acoustics, time series analysis, source identification, structural frequency response, noise control, absorption, barriers, isolation, stiffening, and damping.

Contact: Mrs. Gayle Lyons, SDRC Seminar Coordinator, Structural Dynamics Research Corp., 2000 Eastman Drive, Milford, OH 45150 - (513) 576-2594.

FATIGUE ANALYSIS

Dates: August 13-14, 1980
Place: San Diego, California
Dates: September 10-11, 1980
Place: Cincinnati, Ohio
Objective: The growing understanding of the important factors in the fatigue failure process coupled with the accumulation of new, correctly obtained, fatigue test data and material property and behavior data, has led to the practical application of fatigue analysis methods. The vast improvements in stress analysis, both computerized design analysis (finite element methods, etc.) and experimental testing techniques (digital Fourier analysis, cycle counting methods, etc.) have enabled engineers and designers to get a more fundamental understanding of fatigue. The seminar will address the topics of cyclic stress-strain behavior of metals, fatigue properties of metals and cumulative damage procedures.

Contact: Mrs. Gayle Lyons, SDRC Seminar Coordinator, Structural Dynamics Research Corp., 2000 Eastman Drive, Milford, OH 45150 - (513) 576-2594.

PYROTECHNICS AND EXPLOSIVES

Dates: August 18-22, 1980
Place: Philadelphia, Pennsylvania
Objective: The seminar combines the highlights of "Pyrotechnics and Solid State Chemistry," given the last eleven summers, and "Explosives and Explosive Devices" that made its successful appearance nine years ago. Similar to previous courses, the seminar will be practical so as to serve those working in the field. Presentation of theory is restricted to that necessary for an understanding of basic principles

and successful application to the field. The seminar will be welcomed both by newcomers to the field as well as by experienced men who wish to brush up on latest developments. Coverage emphasizes recent effort, student problems, new techniques, and applications. The prerequisite for this seminar is a bachelor of science degree in engineering or equivalent.

Contact: Mr. E.E. Hannum, Registrar, The Franklin Research Center, Philadelphia, PA 19103 - (215) 448-1236/1395.

SEPTEMBER

UNDERWATER ACOUSTICS

Dates: September 8-12, 1980

Place: University Park, Pennsylvania

Objective: This is a concentrated course designed to cover the basic principles of underwater acoustics as well as current research and recent developments in the field. The course is intended to serve as an introductory course for those who are new to the field but have the appropriate educational background; and as a refresher course for scientists, engineers, program managers, and administrators engaged in underwater acoustics. Topics will include: basic acoustics; sonar concepts; ambient noise; reverberation; underwater acoustics transmission; transducer concepts; nonlinear acoustics/parametric arrays; target physics; and flow noise.

Contact: Robert E. Beam, Conference Coordinator, Pennsylvania State University, Faculty Building, University Park, PA 16802 - (814) 865-5141.

9TH ADVANCED NOISE AND VIBRATION COURSE

Dates: September 15-19, 1980

Place: Institute of Sound and Vibration Research, University of Southampton, UK

Objective: The course is aimed at researchers and development engineers in industry and research establishments, and people in other spheres who are associated with noise and vibration problems. The course, which is designed to refresh and cover the latest theories and techniques, initially deals with fundamentals and common ground and then offers a choice of specialist topics. The course comprises over thirty lectures, including the basic subjects of acoustics, random processes, vibration theory, subjective response and aerodynamic noise, which form the central core of the course. In addition, several specialist applied topics are offered, including aircraft noise, road traffic noise, industrial machinery noise, diesel engine noise, process plant noise, and environmental noise and planning.

Contact: Mrs. O.G. Hyde, ISVR Conference Secretary, The University, Southampton, S09 5NH UK - Southampton (0703) 559122, Ext. 2310 or 752, Telex: 47661.

MODAL ANALYSIS

Dates: September 17-19, 1980

Place: Cleveland, Ohio

Objective: This seminar will provide information on new techniques for identifying dynamic structural weaknesses. The sessions include the use of state-of-the-art instrumentation and software for creating a dynamic structural model in the computer. Techniques will be demonstrated for mode shape calculation and animated displays, computation of mass, stiffness and damping values and modal manipulation methods.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

VIBRATION CONTROL

Dates: September 29 - October 3, 1980

Place: Pennsylvania State University

Objective: The seminar will be of interest and value to engineers and scientists in industry, government, and education. Topics for consideration include dynamic mechanical properties of viscoelastic materials; structural and constrained-layer damping; isolation of machinery vibration from rigid and nonrigid substructures; isolation of impact transients; reduction of vibration in beams, plates, shells, periodic structures, stiffened plates, and rings and ring segments; and characteristics of multi-resonant vibrators. Each student will receive bound lecture notes and copies of six textbooks for his permanent reference.

Contact: Professor John C. Snowdon, Seminar Chairman, Applied Research Laboratory, Pennsylvania State University, P.O. Box 30, State College, PA 16801.

OCTOBER

VIBRATION TESTING

Dates: October 6-9, 1980
Place: San Diego, California
Objective: Topics to be covered are: exciters, fixtures, transducers, test specifications and the latest computerized techniques for equalization, control, and protection. Subjects covered include dynamics and dynamic measurements of mechanical systems, vibration and shock specifications and data generation. Demonstrations are given of sine random and shock testing and of how test specifications are met.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

DIGITAL SIGNAL PROCESSING

Dates: October 21-23, 1980
Place: Atlanta, Georgia
Objective: The mathematical basis for the fast Fourier transform calculation is presented, including frequency response, impulse response, transfer functions, mode shapes and optimized signal detection. Convolution, correlation functions and probability characteristics are described mathematically and each is demonstrated on the Digital Signal Processor. Other demonstrations include spectrum and power spectrum measurements; relative phase measurements between two signals; and signal source isolation.

Contact: Bob Kiefer, Spectral Dynamics, P.O. Box 671, San Diego, CA 92112 - (714) 268-7100.

NOVEMBER

MACHINERY VIBRATION IV

Dates: November 11-13, 1980
Place: Cherry Hill, New Jersey
Objective: Lectures and demonstrations on vibration measurement rotor dynamics and torsional vibration are scheduled. General sessions will serve as a review of the technology; included are the topics of machine measurements, modal vibration analysis, and vibration and noise. The rotor dynamics sessions will include: using finite element, transfer matrix, and nonlinear models; vibration control including isolation, damping, and balancing. The sessions on torsional vibration feature fundamentals, modeling measurement and data analysis, self-excited vibrations, isolation and damping, transient analysis, and design of machine systems.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, 101 W. 55th St., Suite 206, Clarendon Hills, IL 60514 - (312) 654-2254/654-2053.

NEWS BRIEFS

news on current and Future Shock and Vibration activities and events

NUCLEAR POWER PLANT SAFETY SEMINAR
June 11 - 13, 1980
Chicago, Illinois

A seminar on Nuclear Power Plant Equipment Dynamic Qualification is scheduled for June 11, 12 and 13, 1980 at IIT Research Institute, 10 West 35th Street, Chicago, Illinois 60616.

Mr. Darrell Eisenhut, Nuclear Regulatory Commission/Acting Director of the Division of Operating Reactors, will be the guest speaker at the June 11 dinner. The seminar instructors will be: Mr. A.E. Meligi, Sargent and Lundy; Mr. R.R. Robinson, IIT Research Institute; Dr. P.Y. Chen, Nuclear Regulatory Commission; Mr. G. Bohm, Westinghouse; Dr. T. Belytschko, Northwestern University; Mr. R. Allen, Approved Engineering Testing Lab.

Among the topics to be discussed during the seminar are the evaluation of the Nuclear Regulatory Commission (NRC) licensing requirements, present activities in the NRC and possible future requirements for operating and under-construction reactors, related codes and standards, dynamic testing and analysis techniques, verification methods, and cost considerations.

The program is geared for plant designers and builders, equipment manufacturers, and power utility personnel.

The registration fee is $515.00, $465.00 prior to May 16, 1980. The fee includes one dinner, two social hours, luncheons and coffee breaks. Make checks payable to IIT Research Institute and mail to: IIT Research Institute, P.O. Box 4963, Chicago, IL 60680.

For additional information, contact the seminar chairman, Mr. Nestor Iwankiw (312-567-4799).

SYMPOSIUM ON EXPLOSIVES AND PYROTECHNICS
Announcement and Call for Papers

The Symposium on Explosives and Pyrotechnics will be held September 15-17, 1981 in Philadelphia, Pennsylvania. The objective of this Symposium is to provide an arena for presentation and review of new and recent research and development in explosives, pyrotechnics and devices and systems that employ them.

These meetings, of which this will be the eleventh in a series that began in 1954, are regarded as the most comprehensive and important in the e & p area. The published Proceedings represent the "state-of-the-art," and the compendium, together with the many references cited, is truly a detailed technical historical library.

As in past meetings, it is expected that the papers and discussions will be of interest to all of those engaged in use, development, manufacture, research, safety, security, disposal, regulation and many other activities involving pyrotechnics, explosives, propellants and their devices.

These meetings are becoming increasingly international. In 1979 eighteen countries were represented and more are expected to participate in the 1981 Symposium.

You are invited to submit papers for presentation at the 11th Symposium. Papers must be unclassified. (Classified sessions require Government Agency Sponsorship and can be arranged if desired). Please send 500 word abstracts (approximate) to E.E. (TED) Hannum, Registrar, Franklin Research Center, Philadelphia, PA (USA) 19103, by February 14, 1981.

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of articles abstracted in the DIGEST are not available from the SVIC or the Vibration Institute (except those generated by either organization). Inquiries should be directed to library resources. Government reports can be obtained from the National Technical Information Service, Springfield, VA 22151, by citing the AD-, PB-, or N- number. Doctoral dissertations are available from University Microfilms (UM), 313 N. Fir St. Ann Arbor, MI; U.S. Patents from the Commissioner of Patents, Washington, D.C. 20231. Addresses following the authors' names in the citation refer only to the first author. The list of periodicals scanned by this journal is printed in issues 1, 6, and 12.

ABSTRACT CONTENTS

MECHANICAL SYSTEMS

ROTATING MACHINES

(Also see Nos. 1022, 1028, 1035, 1042, 1070, 1109, 1157, 1170, 1174, 1175, 1176, 1177)

80-948

Three-Dimensional Shock Structures for Transonic/Supersonic Compressor Rotors

D.C. Prince, Jr.

General Electric Co., Cincinnati, OH, J. Aircraft, 17 (1), pp 28-37 (Jan 1980) 12 figs, 24 refs

Key Words: Compressors, Rotary compressors, Shock waves

This paper reviews experience at evaluating three-dimensional shock structures for transonic/supersonic compressor rotors, including experimental results obtained by holography, laser velocimetry, and high-frequency pressure transducers. Results are partially explained by obliquity of the shocks in between-blade-streamsurfaces. Procedures for generating analytical flow patterns consistent with experiment, including supersonic/subsonic transition through oblique shocks, are demonstrated.

80-949

Dynamic Analysis of Complex Multi-Level Flexible Rotor Systems

D.F. Li

Ph.D. Thesis, Univ. of Virginia, 354 pp (1979)
UM 7928010

Key Words: Rotors (machine elements), Flexible rotors, *Transfer matrix method*, Component mode method, Unbalanced mass response

Theories are developed for calculating the vibrations of complex multi-component flexible rotor systems based on the transfer matrix method and the component mode method. These complex rotor systems consist of two or more rotating and nonrotating structural components and can not be simplified to the conventional single shaft rotor representation. The methods were compared for accuracy and computational efficiency in the linear dynamic analysis of a two-spool gas turbine engine. Criteria for the selection of the truncated modes in the component mode approach were evaluated. With the transfer matrix method, the nonlinear unbalance response of the engine was obtained by an iterative process using amplitude dependent linearized squeeze film damper parameters.

80-950

Influence of Clearance Between Track and Roll on Dynamic of Grooved Cranks (Einfluss des Rollenspiels auf das dynamische Verhalten von Nutkurvenmechanismen)

G. Nerge

Technische Universität Dresden, Sektion Verarbeitungs- und Verfahrenstechnik, WB Verarbeitungsmaschinen, Maschinenbautechnik, 28 (9), pp 419-421 (Sept 1979) 10 figs

Key Words: Rotors (machine elements), Clearance effects, Experimental data

The clearance between track and roll is an essential factor for the dynamic behavior of the output member and for the smooth running at grooved cranks. Experimental tests prove the rising of acceleration and sound pressure level in dependence on rising clearance between track and roll.

80-951

Rub-Induced Parametric Excitation in Rotors

D.W. Childs

Speed Scientific School, The Univ. of Louisville, Louisville, KY 40208, J. Mech. Des., Trans. ASME, 101 (4), pp 640-644 (Oct 1979) 2 figs, 8 refs

Key Words: Rotors (machine elements), Whirling, Parametric excitation

Analysis is presented which explains earlier hypotheses and experimental results that circumferential stiffness variations induced by rubbing over a portion of a rotor's orbit can lead to parametric excitation of half-speed whirl at a rotor's natural frequency. The results do not explain cited occurrence of 1/3 and 1/4 running-speed whirl associated with the operation of rotating machinery.

80-952

On the Torsional Vibration of Branched Systems Using Extended Transfer Matrix Method

S. Sankar
Dept. of Mech. Engrg., Concordia Univ., Montreal, Canada, J. Mech. Des., Trans. ASME, 101 (4), pp 546-553 (Oct 1979) 7 figs, 4 tables, 9 refs

Key Words: Branched systems, Rotors (machine elements), Torsional vibration, Transfer matrix method

A novel method for the analysis of free vibration of branched torsional systems is presented. The method is radically different from the traditional methods in that an extended transfer matrix relation is formulated for each branch. Numerical examples are given to illustrate the simplicity and straightforwardness of the proposed method in finding the natural frequencies of complex branched torsional systems.

80-953

Self-Excited Vibration of a Rotating Hollow Shaft Partially Filled with Liquid

S. Saito and T. Someya
Machinery Div., Res. Inst., Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan, J. Mech. Des., Trans. ASME, 102 (1), pp 185-192 (Jan 1980) 10 figs, 11 refs

Key Words: Rotors (machine elements), Shafts (machine elements), Fluid-filled containers, Self-excited vibration

The self-excited vibration of a rotating hollow shaft partially filled with viscous liquid is investigated. The motion of liquid and the liquid force is analyzed. The stability of the rotor system is calculated. The mechanism causing the negative damping which is the reason for the instability is discussed.

80-954

Analysis of Coupled Vibration Response in a Rotating Flexible Shaft-Impeller System

N. Hagiwara, S. Sakata, M. Takayanagi, K. Kikuchi and I. Gyobu
Tsuchiura Works, Hitachi, Ltd., 502 Kandatsu, Tsuchiura, Japan, J. Mech. Des., Trans. ASME, 102 (1), pp 162-167 (Jan 1980) 10 figs, 7 refs

Key Words: Rotors (machine elements), Shafts (machine elements), Impellers, Vibration response

This paper presents a way of analyzing the vibration of a rotor shaft system coupled with flexible impellers based on the transfer method. Each of the flexible impellers is modeled so that it comprises an inertia and an elastic hinge based on the assumption that any impeller's vibration mode except its one-nodal diameter has no dynamical connection with a shaft.

80-955

Spline Coupling Induced Nonsynchronous Rotor Vibrations

R.A. Marmol, A.J. Smalley and J.A. Tecza
Pratt & Whitney Aircraft Group, West Palm Beach, FL, J. Mech. Des., Trans. ASME, 102 (1), pp 168-176 (Jan 1980) 22 figs, 1 table, 9 refs

Key Words: Rotor vibration, Couplings, Mathematical model

A mathematical model for predicting spline coupling induced nonsynchronous rotor vibrations is developed, and the predictions are compared with data from a rotor dynamics test rig.

80-956

Response Analysis of a General Asymmetric Rotor-Bearing System

T. Inagaki, H. Kanki and K. Shiraki
Vibration Res. Lab., Takasago Technical Inst., Mitsubishi Heavy Industries, Ltd., Takasago, Japan, J. Mech. Des., Trans. ASME, 102 (1), pp 147-157 (Jan 1980) 9 figs, 8 refs

Key Words: Rotor-bearing systems, Geometric effects, Asymmetry, Vibration response

This paper presents an analytical method for the evaluation of the synchronous response of a general asymmetric rotor-bearing system. In the analysis, slightly asymmetric shaft stiffness in bending and shearing, which distribute along the rotor, and asymmetric transverse mass moment of inertia are considered. The results of the analysis are confirmed by a simple model test and field measurements of large turbosets.

80-957

The Dynamics of Rotor-Bearing Systems with Axial Torque -- A Finite Element Approach

E.S. Zorzi and H.D. Nelson
Mechanical Technology, Inc., Latham, NY 12110, J. Mech. Des., Trans. ASME, 102 (1), pp 158-161 (Jan 1980) 4 figs, 12 refs

Key Words: Rotor-bearing system, Torsional response, Finite element technique

This study investigates the effect of constant axial torque on the dynamics of rotor-bearing systems using a finite element model. The finite element model is used to determine the static buckling torques and the critical speeds of a uniform shaft for short and long bearings.

80-958

The Vibrational Behavior of a Turbine Rotor Containing a Transverse Crack

B. Grabowski
Universität Hannover, Institut für Mechanik, Hannover, Federal Republic of Germany, J. Mech. Des., Trans. ASME, 102 (1), pp 140-146 (Jan 1980) 12 figs, 12 refs

Key Words: Rotors (machine elements), Cracked systems, Modal analysis, Mathematical models

A modal formulation is used to investigate the vibrational behavior of flexible single or coupled rotors containing a transverse crack. A theoretical model has been developed to simulate the crack mechanism. The vibrations, excited by the crack, are independent of the unbalance.

80-959

Reliability Design of Rotating Machine Against Earthquake Excitation

T. Iwatsubo, I. Kawahara, N. Nakagawa and R. Kawai
The Faculty of Engrg., Kobe Univ., Rokko, Nada, Kobe 657, Japan, Bull. JSME, 22 (173), pp 1632-1639 (Nov 1979) 6 figs, 17 refs

Key Words: Rotors (machine elements), Rotating structures, Seismic design, Statistical analysis

This paper deals with the problem of deviations of mass, stiffness, and damping in high speed rotating machines due to the manufacturing process. When the statistical properties of errors of a rotor system and those of an earthquake (i.e. its period, magnitude and statistical character of wave) are known, the statistical properties of the rotor vibration are obtained, and a period of the first collision with the guard of the rotor system is calculated in a statistical sense.

80-960

Vibration of a Rotating Beam with Tip Mass

S.V. Hoa
Dept. of Mech. Engrg., Concordia Univ., Montreal, Canada H3G 1M8, J. Sound Vib., 67 (3), pp 369-381 (Dec 8, 1979) 8 figs, 9 refs

Key Words: Rotors (machine elements), Beams, Mass-beam systems, Rotating structures, Finite element technique

The vibration frequency of a rotating beam with tip mass is investigated. The finite element method is used, a third order polynomial being assumed for the variation of the lateral displacement. The effects of the root radius, the setting angle and the tip mass are incorporated into the finite element model. The results are compared with results from previous authors utilizing Myklestad and extended Galerkin methods.

80-961

Study of Design Constraints on Helicopter Noise

H. Sternfeld, Jr. and C.W. Wiedersum
Boeing Vertol Co., Philadelphia, PA, Rept. No. NASA-CR-159118, 91 pp (July 1979)
N79-32054

Key Words: Rotors, Helicopter rotors, Helicopter noise, Noise prediction

A means of estimating the noise generated by a helicopter main rotor using information which is generally available during the preliminary design phase of aircraft development is presented. The method utilizes design charts and tables which do not require an understanding of acoustical theory or computational procedures in order to predict the perceived noise level, a weighted sound pressure level, or C weighted sound pressure level of a single hovering rotor.

80-962

High Frequency Broadband Rotor Noise

Y. Kim

Ph.D. Thesis, Cornell Univ., 184 pp (1979)
UM 7926922

Key Words: Rotors (machine elements), Noise generation, High frequencies

A method has been developed to find the absolute spectral level of high frequency far-field sound of a subsonic aerodynamic rotor in terms of random load fluctuations on the rotor blades. The analysis deals with frequencies where the radiated sound spectrum is smooth, i.e., above 300 to 400 Hz for a typical helicopter.

RECIPROCATING MACHINES

(See Nos. 1171, 1173)

POWER TRANSMISSION SYSTEMS

(Also see No. 1157)

80-963

Analysis of Vibration in Hydraulic Drive System

H. Akashi, T. Nakagawa and T. Osumi

Faculty of Engrg., Kyoto Univ., Kyoto, Japan, Bull. JSME, 22 (172), pp 1471-1478 (Oct 1979) 14 figs, 19 refs

Key Words: Power transmission systems, Fluid drives, Stick-slip response, Self-excited vibrations

It is well known that stick-slip motion often occurs while operating a hydraulic drive system with plane slideways at low speed. Similar experiments were made with a hydraulic system with comparatively small friction. A detailed analysis of such a motion was made and the results were compared with the experiment.

80-964

The Dynamic Behavior of Hydrostatic Drives (Das dynamische Verhalten hydrostatischer Antriebe)

W. Hahmann

G. Siempelkamp GmbH & Co., Maschinen- und Anlagenbau, Krefeld, Germany, Konstruktion, 31 (12), pp 467-474 (Dec 1979) 8 figs, 5 refs
(In German)

Key Words: Power transmission systems, Vibration control, Hydrostatic drives

Low loss hydrostatic drives produce vibration which can be reduced. This article illustrates how to describe the system by means of simplified equations and to derive the important characteristics of the dynamic behavior.

METAL WORKING AND FORMING

(Also see Nos. 1033, 1034, 1141)

80-965

Calculation of Dynamic Properties of Machine Tool Frames by Means of Finite Element Technique (Berechnung der dynamischen Eigenschaften von Werkzeugmaschinengestellen mit Hilfe der Methode der finiten Elemente)

A. Roscher

Forschungszentrum des Werkzeugmaschinenbaues im VEB Werkzeugmaschinenkombinat "Fritz Heckert" Karl-Marx-Stadt, Maschinenbautechnik, 27 (4), pp 156-160 (Apr 1978) 7 figs, 4 tables, 12 refs
(In German)

Key Words: Machine tools, Finite element technique, Computer programs

An algorithm, based on finite element technique, is presented for the calculation of forced vibrations of thin shells, taking damping effects into consideration. The basic elements used are triangular, quadrangular, beam, and spring elements. Natural frequencies, mode shapes, and polar frequency response locus of the frequency curve function are calculated by means of a computer program. The significance of the frequency curve is illustrated. The application of the computer program is demonstrated in an analysis of a machine tool column.

80-966

On the Relation Between the Fluctuation of the Rotational Speed of the Workpiece and the Fluctuation of the Frequency of the Self-Excited Machine Tool Vibration

S. Ohno and T. Arai

Inst. of Industrial Science, Univ. of Tokyo, Minato-ku, Tokyo, Japan, Bull. JSME, 22 (172), pp 1479-1483 (Oct 1979) 11 figs, 5 refs

Key Words: Machine tools, Machining, Self-excited vibrations

The instantaneous rotational speed of the workpiece and the instantaneous frequency of the self-excited machine tool vibration are measured by an apparatus developed by the authors based on the demodulation of frequency modulated signals. It is experimentally shown that the rotational speed fluctuates periodically because of the slippage of a belt in the driving train and the frequency fluctuates with similar time-history to that of the rotational speed to maintain a constant cycle per rotation of the workpiece.

ELECTROMECHANICAL SYSTEMS

80-967

On the Resonance and Operational Behavior of an Oscillating Electrodynamic Compressor

E. Pollak, W. Soedel, R. Cohen and F.J. Friedlaender

Purdue Univ., West Lafayette, IN 47907, J. Sound Vib., 67 (1), pp 121-133 (Nov 8, 1979) 13 figs, 15 refs

Key Words: Compressors, Mathematical models

A mathematical model of a single piston oscillating compressor is presented. The compressor is of the electrodynamic type. The model results in a set of non-linear equations in terms of piston displacement and current amplitude. Measurements on an existing compressor verified some of the results of the mathematical model. The mathematical model explains certain peculiarities of behavior of this type of compressor, observed directly or reported elsewhere in the literature.

STRUCTURAL SYSTEMS

BRIDGES

(Also see Nos. 1235, 1236)

80-968

Dynamic Behaviour of a Cable-Stayed Bridge

J.F. Fleming and E.A. Egeseli

Univ. of Pittsburgh, Pittsburgh, PA, Intl. J. Earthquake Engr. Struc. Dynam., 8 (1), pp 1-16 (Jan/Feb 1980) 20 figs, 13 refs

Key Words: Bridges, Cables (ropes), Cable stiffened structures, Seismic excitation, Wind-induced excitation, Traffic-induced vibrations

The dynamic response of a cable-stayed bridge to seismic, wind and simulated traffic loads is discussed. The analysis procedure which is used considers non-linear behavior of the cables, caused by the variation in sag with tensile force, and non-linear behavior of the bending members, caused by the interaction of axial and bending deformations. A linear dynamic analysis, however, starting from the dead load deformed state will give results within normally required design accuracy.

80-969

Comparative Structural Analysis of Cable-Stayed Bridges

R.J. Uitto

Ph.D. Thesis, Brigham Young Univ., 163 pp (1979)
UM 8002600

Key Words: Bridges, Cable stiffened structures, Earthquake response, Seismic response

This study compares the responses of sixteen popular cable-stayed bridge styles subjected to static and earthquake loadings. The radiating configuration was discovered to exhibit lower cable and beam stresses than the harp, fan and star types. The study also investigates the influence of expansion joints, deck anchoring and number of cables.

BUILDINGS

(Also see Nos. 1098, 1099, 1101, 1131, 1235, 1236)

80-970

Low Frequency Traffic Noise and Building Vibration

D.J. Martin

Transport and Road Res. Lab., Crowthorne, UK, Rept. No. TRRL-SUPPLEMENTARY-429, 23 pp (1978)
PB-301 037/8GA

Key Words: Buildings, Traffic-induced vibrations, Traffic noise

Building vibrations caused by heavy traffic close to buildings in urban areas were investigated at four sites where a high degree of vibration had been demonstrated or was expected. It was found that low frequency acoustic excitation was responsible for floor vibrations at all sites.

80-971

Room Acoustical Model of External Reverberation

K.W. Yeow

Faculty of Engrg., Univ. of Malaya, Kuala Lumpur, Malaysia, J. Sound Vib., 67 (2), pp 219-229 (Nov 22, 1979) 4 figs, 16 refs

Key Words: Buildings, Rooms, External reverberation, Traffic noise, Mathematical models

A theory of external reverberation in urban built-up environments is developed, based on a classical room acoustical model. In the model, external reverberation is analyzed as a special limiting case of internal reverberation in rooms. Explicit formulae are deduced for the statistical value of the external reverberation time, and the spatial distribution of the external sound field amplitude with distance from a fixed, constant power, sound source, for which comparison with published experimental results is possible.

80-972

System Identification of Tall Vibrating Structures

G.T. Taoka

Dept. of Civil Engrg., Hawaii Univ. at Manoa, Honolulu, HI, Rept. No. NSF/RA-790173, 124 pp (July 1979)

PB-301 064/2GA

Key Words: Buildings, Multistory buildings, Wind-induced excitation, System identification technique

An investigation of the comparative accuracy of four different system identification methods for estimating frequency and damping parameters from identical ambient vibration records of tall structures is reported. Ambient vibration responses under natural wind conditions of five tall structures in Tokyo and Yokohama were recorded. The ambient data thus obtained were analyzed by four system identification methods: filtered correlation, spectral moments, spectral density, and two-stage least square.

80-973

Recommendations for a U.S.-Japan Cooperative Research Program Utilizing Large-Scale Testing Facilities

Earthquake Engrg. Res. Ctr., California Univ., Richmond, CA, Rept. No. UCB/EERC-79/26, NSF/RA-790241, 125 pp (Sept 1979)

PB-301 407/3GA

Key Words: Buildings, Wind-induced excitation, Earthquake resistant structures, Test facilities

The overall objective of the recommended program is to improve seismic safety practices through studies to determine the relationship among full-scale tests, small-scale tests, component tests, and analytical studies.

FOUNDATIONS

(Also see No. 1023)

80-974

Steady State Response of a Circular Foundation on a Transversely Isotropic Medium

D.J. Kirkner

Ph.D. Thesis, Case Western Reserve Univ., 233 pp (1979)

UM 8001463

Key Words: Foundations, Periodic response

The steady state response of a circular foundation vibrating harmonically on a transversely isotropic elastic half space is investigated. The effect of the mass of the foundation on the amplitude of vibration is also studied.

80-975

Investigation of Three-Dimensional Soil-Structure Interaction

V.W. Lee

Ph.D. Thesis, Univ. of Southern California, (1979)

Key Words: Interaction: soil-structure, Seismic excitation, Foundations

The response to seismic excitation of a three-dimensional rigid foundation embedded into an elastic half space is analyzed. The analysis is separated into two physically meaningful subproblems: the first deals with the determination of the restraining forces acting on the foundation; the second deals with the evaluation of driving forces induced by seismic waves on the fixed foundation. This analysis is applied to the case of hemispherical foundation embedded in a homogeneous elastic half space. The exact series solutions of the mixed boundary value problem are presented.

80-976

Proposed Guidelines for Site Investigations for Foundations of Nuclear Power Plants

A.G. Franklin

Army Engineer Waterways Experiment Station, Vicksburg, MS, Rept. No. WES-MP-GL-79-15, 63 pp (July 1979)

AD-A073 219/8GA

Key Words: Nuclear power plants, Foundations, Earthquake resistant structures, Seismic design, Design procedure

The purpose of the proposed guidelines is to describe programs of geological and engineering site investigations that would be adequate to evaluate the safety of the site and to provide the parameters needed for engineering analysis and design of foundations and earthworks. General requirements for site investigations are discussed. Methods of subsurface investigation, including their applicability, limitations, and pitfalls, are described.

HARBORS AND DAMS

(Also see Nos. 1235, 1236)

80-977

Cyclic Behaviour of Dense Coarse-Grained Materials in Relation to the Seismic Stability of Dams

N.G. Banerjee

Ph.D. Thesis, Univ. of California, Berkeley, 273 pp (1979)

UM 8000277

Key Words: Dams, Seismic excitation

The objective of this research was to contribute to the better understanding of the cyclic behavior of dense, granular materials in relation to the seismic stability of dams. A membrane compliance test set-up was designed and a method of testing was evolved for the 12-inch diameter samples. Tests were performed to evaluate membrane strength and modulus, membrane penetration and system compliance, and necessary corrections were incorporated to the basic test data.

80-978

Seismic Dynamic Response by Approximate Methods

R.E. Bieber and H.J. Hovland

Dynamic Analysis Corp., Saratoga, CA, Intl. J. Earthquake Engr. Struc. Dynam., 8 (1), pp 41-53 (Jan/Feb 1980) 15 figs, 18 refs

Key Words: Dams, Seismic response, Dynamic structural analysis, Approximation methods

Current seismic safety evaluation for earth dams relies on approximate methods of analysis for prediction of nonlinear, transient, dynamic response. One of these approximate methods uses a Strain Reduction Factor, and has been widely applied in a variety of one-dimensional and two-dimensional soil structural analyses. A second method considered, *Equivalent Temporal Damping*, has been previously applied to several seismic dynamic analyses of earth dams. The relative accuracy of the two methods is assessed by comparing them with incremental plasticity, nearly exact numerical solutions.

80-979

Reliability of Offshore Structures Under Cyclic Application of Environmental Loading

R.J. Ubaji

Ph.D. Thesis, Univ. of California, Berkeley, 121 pp (1979)

UM 8000552

Key Words: Off-shore structures, Cyclic loading, Pile structures, Water waves

At the present time, design reliability is used in the engineering practice, but most cases studied involve only a single load application. The objective of this research consists of the following major tasks. It involves the collection and organization of up-to-date information on wave statistics, wave force calculations, and soil-structure interaction techniques and uncertainties; and, it involves the determination of the value and distribution of extreme value moment that an offshore platform will experience during its lifetime. A probabilistic design methodology is then developed for calculating the reliability of offshore piles under operating environmental conditions. The method simulates the various wave-pile-soil interactions, and the solution includes the important uncertainties in the soil behavior.

CONSTRUCTION EQUIPMENT

(See No. 1230)

POWER PLANTS

(Also see Nos. 976, 1227, 1236)

80-980

Reserve Seismic Capacity Determination of a Nuclear Power Plant Braced Frame with Piping

T.A. Nelson
Lawrence Livermore Lab., California Univ., Livermore, CA, Rept. No. CONF-790802-35, 11 pp (Feb 27, 1979)
UCRL-82423

Key Words: Nuclear power plants, Seismic response

A typical diagonal braced steel frame was developed to determine the amount of reserve capacity that is available beyond elastic design levels. The frame was analyzed first using elastic static and dynamic analyses. The loadings included dead and live load, an equivalent static lateral earthquake load, two response spectra and a suite of eight earthquake time history records.

80-981
Sloshing of Water in Annular Pressure-Suppression Pool of Boiling Water Reactors Under Earthquake Ground Motions
M. Aslam, W.G. Godden and D.T. Scalise
Lawrence Berkeley Lab., California Univ., Berkeley, CA, Rept. No. LBL-6754, 180 pp (Oct 1979)
NUREG/CR-1083

Key Words: Nuclear power plants, Seismic excitation, Sloshing, Storage tanks

This report presents an analytical investigation of the sloshing response of water in annular-circular as well as simple-circular tanks under horizontal earthquake ground motions. The results are verified with tests.

80-982
Applicability of Flat Plate Methods in Determining Fluid/Structure Interaction Effects in BWR Pressure Suppression Systems
G.S. Holman, E.W. McCauley and S.C.H. Lu
Lawrence Livermore Lab., California Univ., Livermore, CA, Rept. No. CONF-790802-23, 21 pp (Mar 5, 1979)
UCRL-81359

Key Words: Nuclear power plants, Interaction: structure-fluid, Blast shields

Flat plate chord tests are one experimental method used to investigate how fluid/structure interaction effects modify the impulsive loading in nuclear reactor pressure suppression pools. This analytical study examines the applicability of using a flexible flat plate in an otherwise rigid shell to model dynamic pool wall response in a flexible shell pressure suppression torus.

VEHICLE SYSTEMS

GROUND VEHICLES

(Also see Nos. 1120, 1145, 1226)

80-983
Anti-Lock System for Passenger Cars with Digital Electronics - Design and Operation (Antiblockiersystem für Personenwagen mit digitaler Elektronik-Aufbau und Funktion)
H. Leiber and A. Czinczel
Automobiltech. Z., 81 (11), pp 569-583 (Nov 1979)
11 figs, 1 table, 6 refs

Key Words: Automobiles, Brakes (motion arresters), Skid resistance, Computer-aided techniques

An antiskid system called ABS which prevents wheel lockup assuring shorter stopping distances as compared to locked-wheel braking on most road surfaces is described.

80-984
Articulated Vehicles: Stability and Analysis
L.K. Dunbar
Ph.D. Thesis, Univ. of Notre Dame, 90 pp (1979)
UM 8002607

Key Words: Articulated vehicles, Stability methods

Liapunov's direct method of stability analysis is applied to articulated vehicles to develop a method of analysis that considers nonlinear aspects but does not require a large nonlinear time simulation.

80-985
Dynamic Interaction of Moving Vehicles and Structures

T.E. Blejwas, C.C. Feng and R.S. Ayre
School of Mech. and Aerospace Engrg., Oklahoma State Univ., Stillwater, OK 74074, J. Sound Vib., 67 (4), pp 513-521 (Dec 22, 1979) 8 figs, 11 refs

Key Words: Interaction: vehicle-structure, Moving loads, Mathematical models

A procedure is developed for simulating the dynamic interaction between traversing vehicles and structures. Illustrative examples are presented. The results are shown to compare very well with analytical and experimental results.

80-986

Response of a Continuous Guideway on Equally Spaced Supports Traversed by a Moving Vehicle

J. Genin and Y.I. Chung
School of Mech. Engrg., Purdue Univ., West Lafayette, IN 47907, J. Sound Vib., 67 (2), pp 245-251 (Nov 22, 1979) 4 figs, 6 refs

Key Words: Guideways, Moving loads, Critical speed, Interaction: vehicle-guideway, Beams, Continuous beams, Algorithms

An algorithm is developed to analyze the dynamic response of a continuous guideway resting on equally spaced supports being traversed by a moving vehicle. A critical speed, one at which the amplitude of the guideway displacement becomes large, is determined. A parametric study is also presented.

80-987

Geometry and Dynamics of Two Articulated-Bus Concepts (Fahrgeometrie und Fahrdynamik von zewi Gelenkbus-Konzepten)

D. Fuchs
Wehrstaudenstasse 14, 8047 Karlsfeld, Automobiltech. Z., 81 (10), pp 503-513 (Oct 1979) 10 figs (In German)

Key Words: Buses, Articulated vehicles, Cornering effects, Interaction: tire-pavement, Stability

The demand for an engine arrangement in the rear of articulated buses will require comprehensive studies on curve behavior; required coefficient of friction between tires and road with constant acceleration; and driving stability when driving straight ahead at high speed after lane-change maneuver.

80-988

The Aerodynamics of Tracked Ram Air Cushion Vehicles - Effects of Pitch Attitude and Upper Surface Flow

T.M. Barrows, H.C. Curtiss, Jr. and W.F. Putman
Dept. of Mech. and Aerospace Engrg., Princeton Univ., NJ, Rept. No. MAE/TR-1426, DOT-TSC-RSPA-79-17, 142 pp (Oct 1979)
PB80-101827

Key Words: Tracked vehicles, Ground effect machines, Aerodynamic characteristics, Wind tunnel tests

Three types of experiments were conducted on geometrically similar models of a Tracked Ram Air Cushion Vehicle. The first consisted of wind tunnel tests with the vehicle model positioned within a short segment of stationary guideway. In the second series of tests, the vehicle model was towed through a 300-foot guideway. The third type of test used a moving carriage which held the model at a fixed orientation relative to the guideway.

80-989

Study on the Mechanism of Train Noise and its Countermeasures (Part II: The Effect of Velocity and Load, and the Characteristics of Sound Radiation)

H. Matsuhisa and S. Sato
Faculty of Engrg., Kyoto Univ., Kyoto, Japan, Bull. JSME, 22 (173), pp 1626-1631 (Nov 1979) 13 figs, 7 refs

Key Words: Railroad trains, Railway wheels, Noise generation, Sound transmission

In this paper, the effect of the rate of rotation and the load on the vibration, and the characteristics of sound radiation are discussed.

80-990

Two-Dimensional Dynamics of Tracked Ram Air Cushion Vehicles with Fixed and Variable Winglets

L.M. Sweet, H.C. Curtiss, Jr. and R.A. Luhrs
Dept. of Mech. and Aerospace Engrg., Princeton Univ., Princeton, NJ 08544, J. Dyn. Syst., Meas. and Control, Trans. ASME, 101 (4), pp 321-331 (Dec 1979) 7 figs, 6 tables, 13 refs

Key Words: Ground effect machines, Tracked vehicles, Mathematical models, Suspension systems (vehicles), Active isolation, Passive isolation

A linearized model of the pitch-heave dynamics of a Tracked Ram Air Cushion Vehicle is presented. This model is based on aerodynamic theory which has been verified by wind tunnel and towed model experiments.

80-991
Protective Effect of Safety Belts in Side Collisions of Passenger Cars (Uber die Schutzwirkung des Sicherheitsgurtes bei Seitenkollisionen von Personenwagen)
V. Vu-Han and H. Appel
Hansaufer 7, 1000 Berlin, 21, Germany, Automobiltech. Z., 81 (10), pp 525-530 (Oct 1979) 10 figs, 9 refs
(In German)

Key Words: Collision research (automotive), Seat belts

Protection of vehicle passengers in accidents is still an unsolved problem, especially in lateral collisions. The aim of this research work is to clarify the protective effect of the safety belt and the injury pattern of passengers in lateral collisions.

SHIPS
(See No. 1173)

AIRCRAFT
(Also see Nos. 961, 1009, 1010, 1018, 1052, 1076, 1205, 1217, 1220, 1221)

80-992
Commercial Aircraft Flight Deck Noise Criteria
J.E. Mabry, B.M. Sullivan and R.A. Shields
Man-Acoustics and Noise, Inc., Seattle, WA, Rept. No. AD-A072029; FAA-RD-79-66; MAN-1037, 71 pp (Jan 1979)
N79-32969

Key Words: Aircraft, Noise generation

As a method for obtaining results that could contribute to the establishment of commercial jet aircraft flight deck noise criteria, fifty persons were exposed to simulations of various flight deck noise exposure conditions.

80-993
Parameter Identification of Flexible Flight Vehicles Assuming a Low Reduced Frequency Aerodynamic Representation
R.C. Schwanz
Ph.D. Thesis, Univ. of Cincinnati, 184 pp (1979)
UM 8002138

Key Words: Aircraft, Flight vehicles, Parameter identification technique, Least squares method, Aerodynamic loads

This research is concerned with the derivation and numerical demonstration of a recursive, sequential least squares method that may be used to identify the steady and unsteady aerodynamic parameters of a flexible vehicle from its flight test measurements.

80-994
Maximum Likelihood Identification of Aircraft Parameters with Unsteady Aerodynamic Modelling
D.A. Keskar
Ph.D. Thesis, Univ. of Cincinnati, 105 pp (1979)
UM 8002115

Key Words: Aircraft, Parameter identification technique, Aerodynamic loads, Mathematical models

A simplified aerodynamic force model based on the physical principle of Prandtl's lifting line theory and trailing vortex concept has been developed to account for unsteady aerodynamic effects in aircraft dynamics.

80-995
Digital Load Control Applied to Full-Scale Airframe Fatigue Tests
N.K. Mondol and R.M. Potter
Air Force Flight Dynamics Lab., Wright-Patterson AFB, OH, Rept. No. AFFDL-TR-79-3011, 173 pp (May 1979)
AD-A073 588/6GA

Key Words: Aircraft, Airframes, Fatigue tests, Mathematical models, Digital simulation

The modeling, analysis and digital simulation of an analog servo controller and its successful application to a full-scale airframe fatigue test is described. Primary emphasis is on the use of minicomputers for dynamic load control of multiple channels. Hardware and software used to generate functions and control load is described. A brief comparison of digital system performance versus conventional analog controllers is included.

80-996

A Summary of AGARD FDP Meeting on Dynamic Stability Parameters

L.E. Ericsson

Lockheed Missiles and Space Co., Sunnyvale, CA, In: AGARD Stability and Control, 23 pp (May 1979) N79-30220

Key Words: Dynamic stability, Aircraft, Spacecraft, Parametric response

Wind tunnel and flight testing techniques, analytical techniques and nonlinear formulations are covered along with sensitivity and simulator studies to assess the importance of the various dynamic stability parameters.

80-997

Mini-RPV Engine Demonstrator Program

G.E. Abercrombie

Bennett Aerotechnical, Auburn, AL, Rept. No. USARTL-TR-79-15, 93 pp (June 1979) AD-A073 573/8GA

Key Words: Aircraft engines, Design techniques, Balancing techniques, Vibration control

A two-stroke cycle, twin-cylinder, twin-crankshaft, geared, simultaneous firing spark ignition engine was designed and built. The twin-crankshaft, geared configuration allows almost complete engine balance with the resulting exceptionally low vibration levels.

80-998

Resonance Test on Nomad N22 Fitted with External Stores

G. Long and C.M. Bailey

Aeronautical Res. Labs., Melbourne, Australia, Rept. No. ARL-STRUC-NOTE-449, 114 pp (Jan 1978) AD-A074 201/5

Key Words: Aircraft, Wing stores, Resonance tests, Mode shapes, Natural frequencies

A resonance test on the N22 Nomad, fitted with external stores, has been conducted. The natural modes and frequencies of vibration have been measured for two store configurations, in the frequency range up to 30 Hertz.

80-999

Assessment of Airframe Noise

P.J.W. Block

NASA Langley Res. Ctr., Hampton, VA, J. Aircraft, 16 (12), pp 834-841 (Dec 1979) 13 figs, 2 tables, 17 refs

Key Words: Aircraft noise, Airframes, Noise prediction, Scaling

A component method of airframe noise prediction is used to predict levels of operational and proposed aircraft airframe noise to assess the contribution of airframe noise to community noise levels. This is done after first evaluating the prediction method using newly acquired detailed measurements from full-scale aircraft and models. In the course of the evaluation, modeling techniques of airframe noise sources are examined with attention to scaling.

80-1000

An Experimental Study of the Noise Generating Mechanisms in Supersonic Jets (Final Report, 15 Nov. 1977 - 31 Oct. 1979)

D.K. McLaughlin

School of Mech. and Aerospace Engrg., Oklahoma State Univ., Stillwater, OK, Rept. No. NASA-CR-162343, 67 pp (Oct 31, 1979) N79-33967

Key Words: Aircraft noise, Jet noise, Noise generation, Experimental data

Flow fluctuation measurements with normal and X-wire hot-wire probes and acoustic measurements with a traversing condenser microphone were carried out in small air jets in the Mach number range from M = 0.9 to 2.5.

80-1001

Prediction of Jet Noise in Flight From Static Tests

A. Michalke and U. Michel

Hermann-Föttinger-Institut für Thermo- und Fluid-dynamik, Technische Universität Berlin, Berlin, Germany, J. Sound Vib., 67 (3), pp 341-367 (Dec 8, 1979) 17 figs, 32 refs

Key Words: Aircraft noise, Jet noise, Noise prediction

The sound intensity of jet noise from aircraft in flight is derived in a co-ordinate system fixed to the jet engine. For this reason a convected form of the Lighthill equation is solved, with special care taken of jet temperature effects. The theoretical result is checked with measurements. The agreement is remarkably good.

80-1002

Evaluation of Aero Commander Propeller Acoustic Data: Taxi Operations

A.G. Piersol, E.G. Wilby and J.F. Wilby

Bolt, Beranek and Newman, Inc., Canoga Park, CA, Rept. No. NASA-CR-159124, 130 pp (June 1979) N79-32051

Key Words: Aircraft noise, Noise measurement, Experimental data

The acoustic data from ground tests performed on an Aero Commander propeller driven aircraft are analyzed. An array of microphones flush mounted on the side of the fuselage were used to record data. The propeller blade passage noise during operations at several different taxi speeds is considered and calculations of the magnitude and phase of the blade passage tones, the amplitude stability of the tones, and the spatial phase and coherence of the tones are included.

MISSILES AND SPACECRAFT

(Also see Nos. 996, 1160, 1161)

80-1003

Dynamics of a System of Two Satellites Connected by a Deployable and Extendible Tether of Finite Mass, Volume 1

P. Kohler, W. Maag and R. Wehrli

Analytical and Computational Mathematics, Zurich, Switzerland, Rept. No. ESA-CR(P)-1205-V-1, 297 pp (Oct 1978)
N79-31635

Key Words: Satellites, Equations of motion, Spacecraft components, Digital simulation, Computer programs

Relative to the study of the dynamics of tethered satellites, an elementary derivation of the equations of motion is presented.

80-1004

Dynamics of a System of Two Satellites Connected by a Deployable and Extendible Tether of Finite Mass, Volume 2

R. Weber and H. Brauchli

Inst. f. Mechanik, Eidgenoessische Technische Hochschule, Zurich, Switzerland, Rept. No. ESA-CR(P)-1205-V-2, 111 pp (Oct 1978)
N79-31636

Key Words: Satellites, Spacecraft components, Numerical analysis

The mechanical formulation of the full problem of tethered satellites is presented. The system considered consists of two satellites connected by an elastic tether of variable length.

80-1005

The Effectiveness of Spacecraft Testing Programs

A. Krausz

TRW, DSSG, J. Environ. Sci., 23 (1), pp 14-18 (Jan/Feb 1980) 2 figs, 5 tables, 7 refs

Key Words: Spacecraft, Testing techniques

This paper reviews the effectiveness of modern spacecraft testing procedures and suggests some areas for improvement and cost savings. In this paper the fundamental reasons for conducting tests are discussed. The most common procedures for component (i.e., unit), spacecraft and launch base testing are described.

80-1006

Dynamic Interaction Between Solar Arrays and Controlled Spacecraft

D. Poelaert
European Space Agency, Noordwikj, Netherlands, In: ESA Photovoltaic Generators in Space, pp 67-92 (Nov 1978)
N79-30743

Key Words: Solar arrays, Attitude control equipment, Spacecraft, Modal analysis

The fundamental parameters describing the interaction between the dynamics of large, flexible solar arrays and the spacecraft attitude control system are given.

BIOLOGICAL SYSTEMS

HUMAN

(Also see Nos. 1019, 1183)

80-1007

The Effects of Site Selected Variables on Human Responses to Traffic Noise, Part II: Road Type by Socio-Economic Status by Traffic Noise Level

J.S. Bradley and B.A. Jonah
Dept. of Psychology, The Univ. of Western Ontario, London, Canada, J. Sound Vib., 67 (3), pp 395-407 (Dec 8, 1979) 11 figs, 3 tables, 4 refs

Key Words: Human response, Traffic noise

The results of the second part of a field study of human response to traffic noise are reported. The influence of traffic noise level, socio-economic status, and road type (freeway or conventional road) were investigated in a controlled manner determined by subject selection procedures. Human response measures were obtained from interviewer administered questionnaires.

80-1008

The Effects of Site Selected Variables on Human Responses to Traffic Noise, Part III: Community Size by Socio-Economic Status by Traffic Noise Level

J.S. Bradley and B.A. Jonah
Dept. of Psychology, The Univ. of Western Ontario, London, Canada, J. Sound Vib., 67 (3), pp 409-423 (Dec 8, 1979) 12 figs, 6 refs

Key Words: Human response, Traffic noise

This paper reports the results of the third part of a field study of human responses to traffic noise. The influence of traffic noise level, community size, and socio-economic status were investigated in a controlled manner determined by subject selection procedures. Human responses were obtained from interviewer administered questionnaires, and were as spatially and temporally coincident with the noise measurements as possible.

80-1009

Progress in Measuring and Modeling the Effects of Low Frequency Vibration on Performance

H.R. Jex and R.E. Magdaleno
Systems Technology, Inc., Hawthorne, CA, In: AGARD Models and Analogues for the Evaluation of Human Biodyn. Response, Performance and Protect., 11 pp (June 1979)
N79-31930

Key Words: Vibration effects, Low frequencies, Human response, Mathematical models, Measurement techniques

Several facets of the comprehensive biodynamic modeling program presented at the AGARD Aerospace Medical Panel Meeting at Oslo, 1974, were successfully completed and are reported. The development of a variety of lumped parameter models to explain and codify the known data on low-frequency vibration effects and to predict likely effects in new situations was brought to a useful level. The relationship and applications of these and other related models are discussed with respect to their development status and potential applications.

80-1010

The Use of Mathematical Modeling in Crashworthy Helicopter Seating Systems

G.T. Singley, III and J.L. Haley
Army Aviation Res. and Dev. Command, Fort Eustis, VA, In: AGARD Models and Analogues for the Evaluation of Human Biodyn. Response, Performance and Protect., 21 pp (June 1979)
N79-31923

Key Words: Crash research (aircraft), Helicopter seats, Human response, Mathematical models, Impact shock

Crashworthy helicopter accident data revealing injury types related to seat design, seat occupant injury criteria, recent crashworthy seat test data, and crashworthy seat/occupant modeling technology are discussed.

80-1011

The Validation of Biodynamic Models

L.E. Lazarian and H.E. von Gierke

Biodynamics and Bioengineering Div., Aerospace Medical Res. Labs., Wright-Patterson AFB, OH, In: AGARD Models and Analogues for the Evaluation of Human Biodyn. Response, Performance and Protect., 14 pp (June 1979)

N79-31914

Key Words: Mathematical models, Impact shock, Human spine

The biological data required for developing and validating an axial musculoskeletal computer model of subhuman primates that in turn can be used to support the validation of a human response model and assist in predicting human tolerance is presented. Comparisons are made between the various validation approaches. The shortcomings and advantages of the various types of biodynamic data presently collected and available are delineated. Comparative whole body primate spinal impact tolerance curves are presented. Some physical constants for subhuman primate tissue are given, and areas where additional data are required to validate a subhuman primate model are identified.

80-1012

The Use of Spinal Analogue to Compare Human Tolerance of Repeated Shocks with Tolerance of Vibration, Part 1

G. Allen

Human Engrg. Div., Royal Aircraft Establishment, Farnborough, UK, In: AGARD Models and Analogues for the Evaluation of Human Biodyn. Response, Performance and Protect., 15 pp (June 1979)

N79-31926

Key Words: Shock excitation, Vibration excitation, Human response, Human spine, Standards and codes, Mathematical models

A method is evolved for comparing theoretically the compatibility between ISO 2631 limits for human tolerance of vertical vibration and recent proposals for limits of tolerance of repeated shocks based on a spinal analogue. The method is applied to both limits over a wide range of conditions, including a proposal for the maximum acceptable vibration crest factor to be increased from the present value of 3. to 6.

80-1013

A Three Dimensional Discrete Element Dynamic Model of the Spine, Head and Torso

T. Belytschko and E. Privitzer

Dept. of Civil Engrg., Northwestern Univ., Evanston, IL, In: AGARD Models and Analogues for the Evaluation of Human Biodyn. Response, Performance and Protect., 15 pp (June 1979)

N79-31910

Key Words: Mathematical models, Impact shock, Human response, Human spine, Head (anatomy)

A three dimensional, discrete model of the human spine, head and torso is described. This model is an evolution of earlier discrete models which are reviewed and discussed.

80-1014

The Biodynamic Response of the Human Body and its Application to Standards

M.J. Griffin, C.H. Lewis, K.C. Parsons, and E.M. Whitham

Inst. of Sound and Vib. Res., Southampton Univ., UK, In: AGARD Models and Analogues for the Evaluation of Human Biodyn. Response, Performance and Protect., 18 pp (June 1979)

N79-31929

Key Words: Vibration excitation, Human response, Standards and codes

The results of five experiments with groups of up to one hundred-and-twelve subjects and ten experiments with a single subject are given. The experiments were designed to investigate factors that affect the transmission of vertical (z-axis) vibration to the head over the frequency range 1 to 100 Hz. The distributions of response within subject groups were determined as a function of vibration frequency.

80-1015
The Response of a Realistic Computer Model for Sitting Humans to Different Types of Shocks
H. Mertens and L. Vogt
Inst. of Aviation Medicine, Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Bonn, West Germany, In: AGARD Models and Analogues for the Evaluation of Human Biodyn. Response, Performance and Protect., 17 pp (June 1979)
N79-31927

Key Words: Shock excitation, Human response, Test models, Mathematical models

A mechanical model of the human body in the sitting posture is described. The model parameters were derived from the results of steady state vibration experiments conducted under various levels of static acceleration up to +4 Gz.

80-1016
Multiaxis Dynamic Response of the Human Head and Neck to Impact Acceleration
C.L. Ewing, D.J. Thomas and L. Lustick
Naval Aerospace Medical Res. Lab., New Orleans, LA, In: AGARD Models and Analogues for the Evaluation of Human Biodyn. Response, Performance and Protect., 27 pp (June 1979)
N79-31906

Key Words: Impact shock, Human response, Anthropomorphic dummies

The complete kinematic response of the head and the first thoracic vertebral body was measured over the range of variables required for human analog development during impact acceleration experiments. The relationships of the kinematic variables are graphically presented and statistically analyzed.

MECHANICAL COMPONENTS

ABSORBERS AND ISOLATORS

(Also see Nos. 990, 1085, 1155, 1231)

80-1017
Optimum Design of Lanchester Damper for a Viscously Damped Single Degree of Freedom System by Using Minimum Force Transmissibility Criterion
V.A. Bapat and P. Prabhu
Dept. of Mech. Engrg., Indian Inst. of Science, Bangalore 560012, India, J. Sound Vib., 67 (1), pp 113-119 (Nov 8, 1979) 5 figs, 2 refs

Key Words: Absorbers, Viscous damping, Optimum design

The problem of optimum design of a Lanchester damper for minimum force transmission from a viscously damped single degree of freedom system subjected to harmonic excitation is investigated. Explicit expressions are developed for determining the optimum absorber parameters.

80-1018
Development of Crashworthy Passenger Seats for General-Aviation Aircraft
M.J. Reilly and A.E. Tanner
Boeing Vertol Co., Philadelphia, PA, Rept. No. NASA-CR-159100; D210-11336-1, 112 pp (Aug 1979)
N79-31164

Key Words: Energy absorption, Aircraft seats, Crashworthiness

Two types of energy absorbing passenger seat concepts suitable for installation in light twin-engine fixed wing aircraft were developed. An existing passenger seat for such an aircraft was used to obtain the envelope constraints. Ceiling suspended and floor supported seat concept designs were developed. A restraint system suitable for both concepts was designed.

80-1019
Unique Anti-Seismic Damping System Protects Storage Tanks from Earthquakes
S/V, Sound Vib., 13 (11), p 6 (Nov 1979) 5 figs

Key Words: Vibration dampers, Seismic isolation, Earthquake resistant structures, Storage tanks

The danger of rupturing a fuel or chemical tank by earthquake tremors may be dramatically reduced with a unique anti-seismic damping system described in this paper.

80-1020
Principles and Criteria of Vibration Isolation of Machinery
E.I. Rivin
Ford Motor Co., Res. Staff, Dearborn, MI, J. Mech. Des., Trans. ASME, 101 (4), pp 682-692 (Oct 1979) 9 figs, 18 refs

Key Words: Isolators, Vibration isolators, Machinery vibration

This paper considers a complex of problems connected with the systematic approach to vibration isolation of production machinery. After general classification of machinery and the formulation of typical features of a dynamic vibroisolation system of machinery, criteria of effective isolation for main groups of machinery are derived. Designs of isolators complying with these criteria are described.

80-1021
Engine Mountings in the Car with Integrated Viscous Damping - One Way for Better Riding Comfort (Motorlagerungen im Fahrzeug mit integrierter hydraulischer Dämpfung - ein Weg zur Verbesserung des Fahrkomforts)
D. Bosenberg and J. van den Boom
Kronkorbstrasse 7, 8070 Ingolstadt, Germany, Automobiltech. Z., 81 (10), pp 533-539 (Oct 1979) 7 figs, 5 refs
(In German)

Key Words: Automobile engines, Engine mounts, Viscous damping

The paper shows that automobile riding comfort can be improved, without increasing the internal noise, by the introduction of a viscous damper into the engine mounts. The physical basis, as well as the actual design of such dampers, is described. The experimental results were obtained on an Audi NSU 5 cylinder Otto engine. Similar tests with a 6 cylinder engine are also planned.

80-1022
The Promise of Multicyclic Control
J.L. McCloud, III
NASA, Ames Res. Ctr., Moffett Field, CA, Rept. No. NASA-TM-78621; A-7955, 36 pp (Aug 1979)
N79-31137

Key Words: Energy absorption, Rotor blades, Computer programs

Several types of rotors which employ multicyclic control are reviewed and compared. Their differences are highlighted and their potential advantages and disadvantages are discussed. The flow field these rotors must operate in is discussed.

80-1023
Vibration Isolation on Rigid and Nonrigid Foundations
J.C. Snowdon
Applied Res. Lab., Pennsylvania State Univ., University Park, PA, Rept. No. ARL/PSUTM-79-137, 118 pp (July 23, 1979)
AD-A074 737/8

Key Words: Foundations, Machine foundations, Machinery vibration, Vibration isolation, Mathematical models

The problem of isolating machinery vibration from rigid and nonrigid substructures is analyzed in detail. The nonrigid substructures are modeled by clamped-clamped beams and by simply supported plates with small internal damping of the solid type. Both simple and compound mounting systems are analyzed.

80-1024
Acoustical Properties of Highly Porous Fibrous Materials
R.F. Lambert
NASA, Langley Res. Ctr., Hampton, VA, Rept. No. NASA-TM-80135, 68 pp (July 1979)
N79-32053

Key Words: Porous materials, Acoustic absorption, Acoustic liners, Ducts

Highly porous, fibrous bulk sound absorbing materials are studied with a view toward understanding their acoustical properties and performance in a wide variety of applications including liners of flow ducts. The basis and criteria for decoupling of acoustic waves in the pores of the frame and compressional waves in the frame structure are established.

SPRINGS

80-1025
The Stability of Helical Springs (Zur Stabilitat von Schraubenfedern)

E. Kernchen
Institut für Mechanik, Sekr. J 405, Technische Universität Berlin, Jebenstr. 1, D-1000 Berlin 12, Germany, Ing. Arch., 48 (6), pp 383-392 (1979) 7 figs, 6 refs
(In German)

Key Words: Springs (elastic), Helical springs, Stability

A special solution for the nonlinear Kirchhoff-Clebsch equation of helical springs under compression and torsion is presented. In it for large deformations the helical springs are regarded as spherical curves, but for finite deformations they are calculated as elastical problems. A special loading condition is investigated in which the spring, in spite of finite deformations, returns to a helical line, although of different dimensions. The stability of this loading condition is examined by considering the existence of the infinitesimal adjacent position, which is also the equilibrium position. To use this stability criteria the loading must be conservative. The numerical results are compared with the buckling formula of Horingx-Ziegler.

TIRES AND WHEELS

80-1026

The Dynamic Behavior of an Automobile Tire

C.J. Hunckler
Ph.D. Thesis, Purdue Univ., 114 pp (1979)
UM 7926387

Key Words: Tires, Automobile tires, Natural frequencies, Mode shapes, Finite element technique

The natural frequencies and mode shapes of tire structures are studied. A one-dimensional ring analysis technique is briefly presented for understanding. The problem is then more comprehensively studied through the development of an axisymmetric finite element which includes such features as orthotropic material properties, doubly curved geometry and within this element, both the first and second order nonlinear stiffness terms are included. The finite element technique is verified by comparison with several known axisymmetric structure solutions.

80-1027

Analysis and Prediction of Tyre-Soil Interaction and Mobility Performance

P. Boonsinsuk
Ph.D. Thesis, McGill Univ., Canada (1979)

Key Words: Interaction: tire-pavement, Pneumatic tires, Tires, Mathematical models

The purpose of this study is to develop a rational theoretical model for analyzing and/or predicting the mobility performances of pneumatic tires moving on deformable soils.

BLADES

(Also see No. 1176)

80-1028

Research on the Flutter of Axial Turbomachine Blading

F. Sisto and M. Ward
Dept. of Mech. Engrg., Stevens Inst. of Tech., Hoboken, NJ, Rept. No. ME-RT-79004, 39 pp (Sept 1979)
AD-A074 597/6

Key Words: Blades, Turbomachinery blades, Flutter, Aerodynamic loads, Experimental data

Typical aerodynamic moment and free flutter measurements are presented for negative stagger of thin airfoils in an annular cascade. The parameters of interest for the free flutter measurements are incidence angle, torsional amplitude, and reduced frequency (reduced velocity).

80-1029

The Effect of Centrifugal Force on the Natural Frequencies of Elastically Fastened Rotor Blades (Fliehkrafteinfluss auf die Eigenfrequenzen von Laufschaufeln bei grosser Einspannelastizität)

H. Sollmann
Technische Universität Dresden, Sektion Grundlagen des Maschinenwesens, Bereich Dynamik und Betribsfestigkeit, Maschinenbautechnik, 27 (1), pp 37-39 (Jan 1978) 4 figs, 4 refs
(In German)

Key Words: Blades, Rotor blades, Natural frequency

In the evaluation of the effect of centrifugal force on the natural frequencies of motor blades, the centrifugal force coefficient is required. An exact method for the calculation of this coefficient for constant cross section blades, elastically mounted on a wheel disk, is described. The coefficient is presented as dependent on natural frequencies. Borderline cases of rigid mounts and flexible attachments are discussed.

80-1030
On Unsteady Aerodynamic Forces and Moments of Radial Impeller Blades
K. Nishioka and Y. Mitsunaka
National Defense Academy, Yokosuka, Japan, Bull. JSME, 22 (173), pp 1544-1553 (Nov 1979) 4 figs, 14 refs

Key Words: Blades, Impellers, Aerodynamic loads

By method of singularities, the theoretical treatments of two-dimensional centrifugal impeller blades vibrating harmonically with the arbitrary frequencies and the phases are described for the forces and the moments under the assumptions of an incompressible, inviscid, nonstalled flow. Some computed results on the case of radial impeller blades are presented.

BEARINGS

80-1031
Stability Characteristics of Spherical Spiral Groove Bearings (3rd Report, Effects of the Ungrooved Region on Load Capacity and Stability)
Y. Sato
Tokyo Inst. of Technology, Meguro-ku, Tokyo, Japan, Bull. JSME, 22 (172), pp 1484-1490 (Oct 1979) 6 figs, 1 table, 3 refs

Key Words: Bearings, Stability

The characteristics of spherical spiral groove bearings, having ungrooved regions at their bottoms, are investigated. The radial bearing forces and the load capacity are found approximately valid for small radial eccentricities, and then the effects of the ungrooved region on the load capacity and the stability are examined.

80-1032
Development of Mainshaft High-Speed Cylindrical Roller Bearings for Gas Turbine Engines
P.F. Brown, L.J. Dobek, J.D. Robinson and J.R. Miner
Government Products Div., Pratt & Whitney Aircraft Group, West Palm Beach, FL, Rept. No. FR-11453, 106 pp (Oct 1978)
AD-A073 381/6GA

Key Words: Bearings, Roller bearings, Gas turbine engines, Design techniques

This combined analytical and experimental program is aimed at generating a manual that will permit the design of 3.0 MDN cylindrical roller bearings. The roller bearing analysis will be correlated with the results from a series of bearing tests designed to determine, by statistical methods, the effect of geometrical variables on bearing performance.

80-1033
Dynamically Optimum Distance Between the Double Bearings of Machine Tool Spindles (Dynamisch optimaler Lagerabstand zweifach gelagerter Arbeitsspindeln von Werkzeugmaschinen)
W.S. Chomjakow and W. Klepzig
Hochschule Stankin Moskau, Maschinenbautechnik, 27 (4), pp 161-164 (Apr 1978) 8 figs 1 table
(In German)

Key Words: Bearings, Machine tools, Rotor-bearing systems, Stiffness

A method for the optimization of dynamic response of machine tool main spindles in double bearings is investigated. It is shown that there is an optimum distance between bearings when considering dynamic response.

80-1034
The Effect of Bearing Seat Stiffness on the Statically Optimum Distance Between the Double Row Rolling Bearings of Machine Tool Spindles (Einfluss der Kontaktsteife der Lagersitze auf den statisch optimalen Lagerabstand zweifach walzgelagerter Arbeitsspindeln von Werkzeugmaschinen)
W. Klepzig
Ingenieurhochschule Zwickau, Germany, Maschinenbautechnik, 27 (1), pp 13-16 (Jan 1978) 6 figs, 2 tables, 14 refs
(In German)

Key Words: Bearings, Machine tools, Rotor-bearing systems, Joints (junctions), Stiffness

The stiffness of double row cylindrical roller bearings is calculated by including the elasticity of bearing seat joints in the approximation equation. The statically optimum bearing distance and the stiffness of front cantilever for the required speed are presented graphically by means of simplifying assumptions.

80-1035

The Effectiveness of Squeeze-Film Damper Bearings Supporting Rigid Rotors Without a Centralising Spring

R A Cookson and S.S. Kossa

Cranfield Inst. of Tech., School of Mechanical Engrg., Applied Mechanics Group, Bedford, UK, Intl. Mech. Sci., 21 (11), pp 639-650 (1979) 16 figs, 1 table, 12 refs

Key Words: Bearings, Squeeze-film bearings, Rotors, Rigid rotors

A method has been devised for comparing the effectiveness of squeeze-film damper bearings of various configurations. The analysis in this report is limited to the case of rigid-rotors without parallel flexible supports.

80-1036

Influence of the Gas-film Inertia Forces on the Squeeze Damping of an Externally Pressurized, Gas-Lubricated Thrust Collar Bearing with Multiple-holes Admission

A. Mori, N. Iwamoto and H. Mori

Faculty of Tech., Kyoto Univ., Kyoto, Japan, Bull. JSME, 22 (173), pp 1678-1684 (Nov 1979) 13 figs, 3 refs

Key Words: Squeeze film bearings, Squeeze film dampers, Stiffness coefficients, Damping coefficients, Inertial forces

Based on the approach to average out the inertia forces across the film thickness, modified Reynolds equations and their boundary conditions are introduced to evaluate the influence of the inertia forces of a gas film on the dynamic properties of an externally pressurized, gas lubricated, parallel thrust collar bearing with multiple holes admission.

80-1037

Dynamic Characteristics of Air-Lubricated Slider Bearings under Submicron Spacing Conditions

K. Ono, K. Kogure and Y. Mitsuya

Musashino Electrical Communication Lab., Nippon Telegraph and Telephone Public Corp., Musashinoshi, Tokyo, Japan, Bull. JSME, 22 (173), pp 1672-1677 (Nov 1979) 12 figs, 7 refs

Key Words: Bearings, Slider bearings, Dynamic properties, Lubrication

Dynamic characteristics of air-lubricated slider bearings operating under submicron spacing conditions are investigated theoretically and experimentally. From the modified Reynolds equation, considering slip flow effects, the properties of air film stiffness and damping are calculated in the frequency domain by small perturbation method and finite difference method.

GEARS

(Also see No. 1178)

80-1038

Evaluation of High-Contact-Ratio Spur Gears with Profile Modification

D.P. Townsend, B.B. Baber and A. Nagy

NASA, Lewis Res. Ctr., Cleveland, OH, Rept. No. NASA-TP-1458, E-9949, 24 pp (Sept 1979) N79-31604

Key Words: Gears, Spur gears, Fatigue tests

Scoring tests, surface fatigue tests, and single-tooth bending fatigue tests were conducted with four sets of spur gears of standard design and three sets of spur gears of new-tooth-form design.

80-1039

Analysis of the Vibratory Excitation of Gear Systems. II: Tooth Error Representations, Approximations, and Application

W.D. Mark

Bolt Beranek and Newman, Inc., 50 Moulton St., Cambridge, MA 02138, J. Acoust. Soc. Amer., 66 (6), pp 1758-1787 (Dec 1979) 27 figs, 3 tables, 21 refs

Key Words: Gears, Helical gears, Vibration excitation

The second part of a theory is presented for predicting the vibratory excitation of gear systems from fundamental descriptions of gear tooth elastic properties and deviations of tooth faces from perfect involute surfaces. Detailed results are given for rectangular tooth face contact regions using two-dimensional Legendre polynomial expansions of local tooth-pair stiffnesses and stiffness-weighted deviations of tooth faces from perfect involute surfaces.

80-1040

Transfer Functions for Cranks with Double Elevating Motions (Übertragungsfunktionen fur Kurvengetriebe mit Doppelhubbewegungen)

J. Volmer, R. Brock and G. Uhlig

Technische Hochschule Karl-Marx-Stadt, Maschinenbautechnik, 28 (9), pp 414-418 (Sept 1979) 7 figs, 8 refs

(In German)

Key Words: Gears, Gear drives, Transfer functions

To obtain two strokes per revolution of the main shaft in the driving of sliding carriages of processing machines, oval shaped cams are used. The ellipse and the epicycloid are the shapes used. Kinematic parameters of these shapes are compared with the standard known transfer functions, such as sinusoids and polynomials. This curvature and pitch angle of such shapes was found to be particularly suited for the hydrodynamically lubricated sliding parts.

COUPLINGS

(Also see No. 955)

80-1041

Methods for Modelling Flanged and Curvic Couplings for Dynamic Analysis of Complex Rotor Constructions

R.H. Bannister

Lecturer in Machine Dynamics, Cranfield Inst. of Tech., Cranfield, Bedford UK, J. Mech. Des., Trans. ASME, 102 (1), pp 130-139 (Jan 1980) 15 figs, 1 table, 3 refs

Key Words: Couplings, Rotors (machine elements), Computer programs, Finite element technique, Graphic methods

Design charts are presented whereby the practicing design engineer can determine the equivalent flexural stiffness of flanged or curvic (toothed) couplings. Results are obtained by computing the centre line slope generated by an applied couple using a Program for Automatic Finite Element Calculations (PAFEC 75). Graphical data is provided allowing the equivalent second moment of area to be determined for flanged couplings or stress contour lines describing the effective load carrying material for curvic coupled disc assemblies.

80-1042

The VULKAN VULAFLEX Coupling For Extreme Shaft Displacements (Die hochverlagerungsfähige VULKAN-VULAFLEX-Kupplung)

W. Deckert

Siepenhohe 20, D-4630 Bochum 1, W. Germany, MTZ Motortech. Z., 40 (11), pp 523-526 (Nov 1979) 9 figs, 7 refs

Key Words: Couplings, Alignment, Shafts (machine elements)

A new coupling principle is introduced, intended to compensate large shaft displacements, in the axial as well as in the radial and angular directions. The principle of its operation and the constructive design are described, in addition the permissible displacements - dependent on torque, speed and exterior diameter - have been graphically represented. Further, the possibility to combine this coupling type with torsionally highly flexible and torsionally damping couplings is mentioned. Finally, several executed application examples are explained.

LINKAGES

80-1043

The Approximation of Dynamic Stability of the Motion of Plane Linkages (Zur naherungsweisen Berechnung der dynamischen Stabilität der Bewegung ebener Koppelgetriebe)

N. Van Khang

Lehrstuhl f. Theoretische Mechanik, Polytechnische Hochschule Hanoi, SR Vietnam, Maschinenbautechnik, 27 (7), pp 310-312 (July 1978) 1 fig, 1 table, 6 refs

(In German)

Key Words: Linkages, Dynamic stability, Approximation methods

In the article an approximate method for the calculation of the dynamic stability of the motion of plane linkages is presented. The method is particularly attractive in the application of digital computers.

VALVES

80-1044

Development of Silent Valves in Oil Hydraulics (Entwicklung gerauscharmer Ventile der Ölhydraulik)

O. Eich
Barmer Maschinenfabrik AG, Remscheid, Germany,
Konstruktion, 31 (12), pp 461-466 (Dec 1979) 11 figs, 5 refs
(In German)

Key Words: Valves, Cavitation noise, Noise reduction

The main cause of valve noise is flow cavitation, which occurs during high flow velocities at the cross sectional reductions. Cavitation caused by these large pressure differentials can be gradually reduced by a series of synchronously adjustable "resistors." The individual teps in the series consist of several parallel "resistors."

80-1045

Aerodynamic Study on Noise and Vibration Generated in High Pressure Gas Valves. Part 1: Flow Patterns and Noise of Supersonic Air Flow Discharged Through Conical Valve Plugs into Atmosphere

M. Nakano, E. Outa and K. Tajima
School of Science and Engrg., Waseda Univ., Okubo 3-4-1, Shinjuku, Tokyo, Japan,
Bull. JSME, 22 (173), pp 1578-1586 (Nov 1979) 13 figs, 6 refs

Key Words: Noise generation, Vibration excitation, Valves

Flow patterns of a supersonic air flow and the related noise characteristics are studied by experiment for simplified geometries of the valve. The valve consists of a conical plug and a plane seat, and high pressure air is discharged through it into atmosphere.

STRUCTURAL COMPONENTS

CABLES

(See No. 968)

BARS AND RODS

80-1046

Design and Construction of Dynamically Lubricated Guide Bars (Geradführungen mit dynamischer Schmierung - ein Beitrag zur Gestaltung und Auslegung von Geradführungen)

R. Seybold
Entwicklung und Schutz technischer Produkte an der Gesamthochschule Wuppertal, Solingen, Germany,
Konstruktion, 31 (10), pp 399-403 (Oct 1979) 10 figs, 9 refs
(In German)

Key Words: Machinery components, Bars

The paper demonstrates that, in addition to the usual designs for the normal pressure and volume ranges, dynamically and lubricated guide bars are possible.

80-1047

Vibrations of a Connecting System of Curved Bar (In-Plane)

K. Suzuki, A. Asakura, and S. Takahashi
Faculty of Engrg., Yamagata Univ., Yonezawa, Japan,
Bull. JSME, 22 (172), pp 1439-1447 (Oct 1979) 11 figs, 11 refs

Key Words: Bars, Curved beams, Joints (junctions), Natural frequencies, Mode shapes

In this paper, we express the Lagrangian of in-plane vibrations of a uniform curved bar of which the center line is a plane curve by unknown boundary values, that is, displacements and slopes at boundary. A method is shown for analyzing in-plane vibrations of a system connecting uniform curved bars. The vibrations of a symmetric U-bar with built-in ends composed of an elliptic arc bar and straight bars and

those of a catenary curved bar and straight bars are analyzed. Then the natural frequencies and the mode shapes are obtained.

80-1048

Vibrations of a Connecting System of Curved Bar (Out-of-Plane)

K. Suzuki and S. Takahashi

Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, Bull. JSME, 22 (172), pp 1448-1455 (Oct 1979) 9 figs, 9 refs

Key Words: Bars, Curved beams, Joints (junctions), Natural frequencies, Mode shapes

The Lagrangian of out-of-plane vibrations of a uniform curved bar of which the center line is a plane curve by unknown boundary values, that is, displacements and slopes at boundary are expressed. A method is shown for analyzing out-of-plane vibrations of a system connecting uniform curved bars. The vibrations of a symmetric U-bar with built-in ends composed of an elliptic arc bar and straight bars and those of a catenary curved bar and straight bars are analyzed. Then the natural frequencies and the mode shapes are obtained.

80-1049

Small Torsional Vibration Superposed on Finitely Deformed State of a Circular Cylindrical Rod of Transversely Isotropic Elastic Material

S.R. Chaudhuri

Vivekananda Sangha, Bansberia, Hooghly, Pin, 712502, West Bengal, India, Intl. J. Engr. Sci., 17 (12), pp 1273-1281 (1979) 11 refs

Key Words: Rods, Cylinders, Torsional vibration

Starting with a class of small deformations superposed on a finitely deformed state of a transversely isotropic elastic solid, we study a problem of small torsional vibration superposed on homogeneous finitely deformed state of a circular cylindrical rod made of transversely isotropic elastic material.

BEAMS

(Also see Nos. 960, 986, 1062, 1101, 1117)

80-1050

A Method of Stability Analysis for Non-Linear Vibration of Beams

K. Takahashi

Dept. of Civil Engrg., Nagasaki Univ., Nagasaki, Japan, J. Sound Vib., 67 (1), pp 43-54 (Nov 8, 1979) 10 figs, 9 refs

Key Words: Beams, Periodic excitation, Stability

In this paper, a method of stability analysis for the large amplitude, steady state response of a non-linear beam under periodic excitation is presented. The stability problem is investigated by studying the behavior of a small perturbation of the steady state response which results in a coupled Hill-type equation. The problem is transformed by the harmonic balance method into an eigenvalue problem of a non-symmetric matrix. The effectiveness and the accuracy of the proposed method for a Mathieu equation are examined and the application to the stability analysis of the non-linear vibrations of a beam is presented.

80-1051

Radiation Efficiencies of Beams in Flexural Vibration

R.K. Jeyapalan and E.J. Richards

Institute of Sound and Vibration Res., Univ. of Southampton, Southampton S09 5NH, UK, J. Sound Vib., 67 (1), pp 55-67 (Nov 8, 1979) 10 figs, 11 refs

Key Words: Beams, Flexural vibration, Radiation efficiency method, Noise source identification, Diagnostic techniques, Machinery components

In this paper simplified equations (similar to those in use to calculate the radiation efficiencies of plates) are given to estimate the radiation efficiencies of beams of arbitrary cross-section which are part of many fabricated machines found in industry.

80-1052

Theoretical Analysis of the Transient Response of a Wing to Non-Stationary Buffet Loads

B.H.K. Lee

National Aeronautical Establishment, Ottawa, Ontario, Canada, Rept. No. NAE-LR-597, NRC-17465, 88 pp (Apr 1979)
AD-A073 702/3GA

Key Words: Aircraft wings, Wind-induced excitation, Beams, Cantilever beams

A method for predicting the response of a wing to non-stationary buffet loads is presented. The wing is treated as a

cantilever beam with known mass distribution. Analytical expressions for the mean square response of the wing displacement are derived using a power spectral density for the random part of the applied load, similar to that used in tne theory of isotropic turbulence. The effects of damping, ratio of the undamped natural frequency of the system to the half power frequency of the power spectral density, length of time segment, and duration of applied load on the response of the wing have been investigated for three examples of the load versus time histories.

80-1053

Investigation of the Suitability of the Bazant Endochronic Material Model for Modelling the Concrete in a SAMSON Analysis of a Reinforced Concrete Beam

J.W. Jeter, Jr.

VMI Research Labs., Lexington, VA, 19 pp (July 1979)

AD-A074 202/3

Key Words: Beams, Reinforced concrete, Mathematical models, Computer programs

This investigation involved evaluating the potential of the Bazant endochronic plain concrete model as a possible avenue to an accurate model of the behavior of dynamically loaded reinforced concrete structures.

COLUMNS

(See No. 1101)

FRAMES AND ARCHES

80-1054

Investigation of the Nonlinear Characteristics of a Three Story Steel Frame Using System Identification

I. Kaya and H.D. McNiven

Earthquake Engrg. Research Ctr., California Univ., Richmond, CA, Rept. No. UCB/EERC-78/25, NSF/RA-780681, 97 pp (Dec 1978)

PB-301 363/8GA

Key Words: Frames, Steel, Mathematical models, Seismic response, Earthquake resistant structures, Nonlinear response, Hysteretic damping, System identification technique

In the study reported here, two mathematical models were constructed of a three-story steel frame that are meant to predict its responses to seismic disturbances. This is an extension of work previously reported, devoted to the construction of mathematical models of the same frame to predict its linear response. The models constructed in this work are meant to predict nonlinear response.

PANELS

(See No. 1091)

PLATES

(Also see Nos. 1090, 1115, 1117)

80-1055

Classical Analyses of Laminated Bimodulus Composite-Material Plates

C.W. Bert

School of Aerospace Mech. and Nuclear Engrg., Oklahoma Univ., Norman, OK, Rept. No. OU-AMNE-79-10A, TR-4A, 42 pp (Aug 1979)

AD-A074 125/6

Key Words: Plates, Rectangular plates, Layered materials, Periodic excitation

A differential-equation formulation is presented for the equations governing the small-deflection elastic behavior of thin plates laminated of anisotropic bimodulus materials (which have different elastic stiffnesses depending upon the sign of the fiber-direction strains). As a basis for comparative evaluation of a finite-element formulation presented in Technical Report No. 3 of the contract, exact closed-form solutions are presented for two cross-ply-laminated plate problems: a freely supported rectangular plate subjected to a sinusoidally distributed normal pressure, and a fully clamped elliptic plate subjected to uniform normal pressure.

80-1056

Finite-Element Analysis of Laminated Bimodulus Composite-Material Plates

J.N. Reddy and W.C. Chao

School of Aerospace Mechanical and Nuclear Engrg., Oklahoma Univ., Norman, OK, Rept. No. OU-AMNE-79-18, TR-7, 25 pp (Aug 1979)
AD-A074 184/3

Key Words: Plates, Rectangular plates, Composite materials, Fiber composites, Finite element technique, Periodic excitation

Finite-element analysis of the equations governing the small-deflection elastic behavior of thin plates laminated of anisotropic bimodulus materials (which have different elastic stiffnesses depending upon the sign of the fiber-direction strain) is presented. Single-layer and two-layer cross-ply, simply-supported rectangular plates subjected to sinusoidally distributed normal pressure and uniformly distributed normal pressure are analyzed.

80-1057

Off-Center, Low Velocity, Transverse Normal Impact of a Simply Supported Plate

R.E. Llorens and E.J. McQuillen

Aircraft and Crew Systems Technology Directorate, Naval Air Development Ctr., Warminster, PA, Rept. No. NADC-79215-60, 61 pp (Sept 1979)
AD-A074 946/5

Key Words: Plates, Impact response (mechanical)

A theoretical solution for the response of a simply supported plate to off-center low speed transverse impact is presented. This solution is empirically corrected, on the basis of visco-elastic beam analysis, to admit damping. Comparison of the numerical predictions of the corrected theory with central impact test results on graphite-epoxy composite laminates shows good agreement. The structural dynamic response model consists of a special orthotropic plate impacted by a rigid mass.

80-1058

Vibration Analysis of Plates of Arbitrary Shape – A New Approach

D. Bucco, J. Mazumdar, and G. Sved

Univ. of Adelaide, Adelaide, South Australia 5001, Australia, J. Sound Vib., 67 (2), pp 253-262 (Nov 22, 1979) 6 figs, 6 tables, 21 refs

Key Words: Plates, Fundamental frequency, Finite strip method

The so-called finite strip method combined with the deflection contour method has proved highly successful in the analysis of bending of thin elastic plates of arbitrary shape. Here the same technique is used to obtain the fundamental frequency of plates of arbitrary shape. Several representative plate problems of irregular boundaries are treated by the proposed method. For all cases, comparison of the results are made with other known solutions and the agreement appears to be excellent.

80-1059

Vibration of a Plate Having a Circular Inside Edge and a Cornered Outside Edge Consisting of Arcs

K. Nagaya

Dept. of Mech. Engrg., Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, J. Acoust. Soc. Amer., 66 (6), pp 1788-1794 (Dec 1979) 4 figs, 2 tables, 12 refs

Key Words: Plates, Flexural vibration

This paper is concerned with a transverse vibration problem of a thin plate having a circular inside edge and a cornered outside edge consisting of some arcs. The classical plate theory is applied and the eigenvalue problem of the plate is solved by the use of the exact solution of the equation of motion which satisfies the inner boundary conditions. The boundary conditions at the outer edge are satisfied by means of the Fourier expansion method. Numerical calculations are carried out for a plate having a clamped circular inside edge and a free outer one consisting of three arcs. Experimental results are also given as an additional check of this analysis.

80-1060

Aeroelastic Stability Analysis of Supersonic Cascades

J.A. Strada, W.R. Chadwick, and M.F. Platzer

U.S. Navy, Navy Space Systems Activity, Los Angeles, CA, J. Engr. Power, Trans. ASME, 101 (4), pp 533-541 (Oct 1979) 15 figs, 28 refs

Key Words: Plates, Blades, Flutter, Aeroelasticity

This paper presents three solutions for the analysis of supersonic flow past oscillating cascades with subsonic leading-edge locus. An elementary solution is first developed for the case of slowly oscillating finite and infinite flat plate cascades which provides simple analytical expressions for the unsteady pressure distributions. Comparisons with other solutions show generally excellent agreement. Furthermore, a previously developed linearized characteristics solution for finite flat plate cascades is applied to the case of super-resonant blade motions. Again, the unsteady blade loading distributions are found to be in good agreement with Verdon's recent infinite cascade solution for this case. Finally, a nonlinear method of characteristics solution for finite cascades is described which permits the analysis of blade thickness effects on flutter. At this time, only the inlet and passage flow computations have been completed which are compared with the available experimental information.

80-1061

Large Amplitude Vibrations of Thin Elastic Plates by the Method of Conformal Transformation

B. Banerjee and S. Datta
Dept. of Mathematics and Dept. of Mech. Engrg., Jalpaiguri Government Engrg. College, Jalpaiguri, W. Bengal, India, Intl. J. Mech. Sci., 21 (11), pp 689-696 (1979) 2 tables, 24 refs

Key Words: Plates, Large amplitude, Vibration response, Conformal mapping

A unified method for investigating large amplitude vibrations of thin elastic plates of any shape under clamped edge boundary conditions is presented, based on Von Karman governing equations generalized to the dynamical case. The conformal mapping technique is introduced and the domain is conformally transformed on to the unit circle. The deflection function is chosen beforehand in conformity with the prescribed boundary conditions and the stress function is solved taking only the first term of the mapping function. The transformed differential equations are solved by the Galerkin procedure to obtain the second order nonlinear differential equation for the unknown time function. The time equation is readily solved in terms of Jacobian elliptic functions. Frequency of linear and nonlinear oscillations as well as static nonlinear case are analyzed for plates of circular, and regular polygonal shape. Results obtained are compared with other known results. From the comparative study of different results it is observed that the first term approximation of the mapping function yields fairly accurate results with less computational effort.

80-1062

Free Vibration of Polar-Orthotropic Sector Plates

T. Irie, G. Yamada, and F. Ito
Dept. of Mech. Engrg., Hokkaido Univ., Sapporo, Japan, J. Sound Vib., 67 (1), pp 89-100 (Nov 8, 1979) 8 figs, 1 table, 11 refs

Key Words: Plates, Rings, Beams, Natural frequencies, Mode shapes, Ritz method

The free vibration of ring-shaped polar-orthotropic sector plates is analyzed by the Ritz method using a spline function as an admissible function for the deflection of the plates. For this purpose, the transverse deflection of a sector plate is written in a series of the products of the deflection function of a sectorial beam and that of a circular beam satisfying the boundary conditions. The frequency equation of the plate is derived by the conditions for a stationary value of the Lagrangian. The present method is applied to ring-shaped polar-orthotropic sector plates with some combination of boundary conditions, and the natural frequencies and the mode shapes are calculated numerically up to higher modes.

80-1063

On the Analysis of the Doubly Connected Problem of Vibrating Polygonal Plates

K. Nagaya
Dept. of Mech. Engrg., Faculty of Engrg., Yamagata Univ., Yonozawa, Japan, J. Acoust. Soc. Amer., 66 (6), pp 1795-1800 (Dec 1979) 2 figs, 4 tables, 13 refs

Key Words: Plates, Vibration response

In this paper a method for solving vibration problems of thin polygonal plates, with circular inside edges, is presented. The frequency equations of the polygonal plates are given for various combinations of outer and inner boundary conditions. Numerical calculations are carried out for cases of triangular, square, pentagonal, and hexagonal plates.

80-1064

A Finite Element Analysis of the Harmonic Response of Damped Three-Layer Plates

E. Ioannides and P. Grootenhuis
Dept. of Mech. Engrg., Imperial College, Exhibition Rd., London SW7 2BX, UK, J. Sound Vib., 67 (2), pp 203-218 (Nov 22, 1979) 9 figs, 23 refs

Key Words: Plates, Layered materials, Viscoelastic core-containing media, Viscoelastic damping, Harmonic response, Finite element technique

Solutions have been obtained for the vibration response under harmonic excitation of three-layer plates with a constrained viscoelastic layer (e.g., plates with two metallic outer layers and a viscoelastic core) by means of a finite element method. Damping has been introduced by replacing

the real modulus of the viscoelastic material by a complex equivalent which accounts for the phase difference between strain and stress. Triangular finite elements were used with different numbers of degrees of freedom and the dynamic stiffness of the overall structure was calculated. The present method allows for the nonlinear stress-strain behavior of the viscoelastic material, the effects of the rotatory inertia and the extension within the viscoelastic core.

80-1065
A Comparison of Closed-Form and Finite-Element Solutions of Thick, Laminated, Anisotropic Rectangular Plates

J.N. Reddy
Dept. of the Navy, Office of Naval Research, Structural Mechanics Program, Arlington, VA 22217,
Rept. No. OU-AMNE-79-19, 40 pp (Dec 1979) 5 figs, 9 tables, 17 refs

Key Words: Plates, Rectangular plates, Layered materials, Free vibration, Finite element technique

In this study the effects of reduced integration, mesh size, and element type (i.e. linear or quadratic) on the accuracy of a penalty finite element based on the theory governing thick, laminated, anisotropic composite plates, are investigated. In order to assess the accuracy of the present element, exact closed-form solutions are developed for cross-ply and antisymmetric angle-ply rectangular plates simply supported and subjected to sinusoidally distributed mechanical and/or thermal loadings, and free vibration.

80-1066
Large Amplitude Flexural Vibration of Eccentrically Stiffened Plates

T.K. Varadan and K.A.V. Pandalai
Dept. of Aeronautics, Indian Inst. of Tech., Madras 600036, India,
J. Sound Vib., 67 (3), pp 329-340 (Dec 8, 1979) 4 figs, 2 tables, 9 refs

Key Words: Plates, Rectangular plates, Stiffened plates, Flexural vibration

The large amplitude free flexural vibrations of thin, orthotropic, eccentrically and lightly stiffened elastic rectangular plates are investigated. Clamped boundary conditions with movable in-plane edge conditions are assumed. A simple modal form of one-term transverse displacement is used and in-plane displacements are made to satisfy the in-plane equilibrium equations. By using Lagrange's equation, the modal equations for the nonlinear free vibration of stiffened plates are obtained for the cases when the stiffeners are assumed to be smeared out over the entire surface of the plate, and when the stiffeners are located at finite intervals. Numerical results are obtained for various possibilities of stiffening and for different aspect ratios of the plate.

80-1067
Free Vibration of Rectangular Plates with Edges Having Different Degrees of Rotational Restraint

M. Mukhopadhyay
Dept. of Naval Architecture, Indian Inst. of Tech., Kharagpur 721 302, India,
J. Sound Vib., 67 (4), pp 459-468 (Dec 22, 1979) 2 figs, 9 tables, 8 refs

Key Words: Plates, Rectangular plates, Natural frequencies, Numerical analysis

A numerical method is developed as a basis for determining natural frequencies of rectangular plates possessing different degrees of elastic restraints along the edges. The basic functions satisfying the boundary conditions along two opposite edges for such cases have been derived.

80-1068
Large Deflection Static and Dynamic Analysis of Isotropic and Orthotropic Annular Plates

R.S. Alwar and B.S. Reddy
Dept. of Applied Mechanics, Indian Inst. of Tech., Madras 600 036, India,
Intl. J. Nonlin. Mech., 14 (5/6), pp 347-359 (1979) 12 figs, 8 refs

Key Words: Plates, Circular plates, Non-linear response, Structural dynamic response, Chebyshev polynomials

In the present paper, Chebyshev series are employed to obtain the non-linear static and dynamic response of isotropic and orthotropic annular plates. The non-linear partial differential equations obtained from von Karman's large deflection plate theory have been solved by using the Chebyshev series in the space domain and the Houbolt numerical integration scheme in the time domain. Two different sets of boundary conditions of the annulus are investigated and detailed numerical results have been obtained for different cases of orthotropy and geometry.

80-1069

Vibration Analysis of Circular Segment Shaped Plates

H.B. Khurasia and S. Rawtani
Dept. of Applied Mechanics, Maulana Azad College of Technology, Bhopal 462 007, India, J. Sound Vib., 67 (3), pp 307-313 (Dec 8, 1979) 4 figs, 7 refs

Key Words: Plates, Circular plates, Natural frequencies, Mode shapes, Finite element technique

Circular segment shaped plates are analyzed to determine their natural frequencies and mode shapes of vibration. The analysis is based on the finite element approach: the curved sided triangular plate bending element is used. The effect of variation of the size of the plate on the vibrational characteristics is studied and several important conclusions are made.

80-1070

A Cumulative Fatigue Damage Model for Gas Turbine Engine Disks Subjected to Complex Mission Loading

T.A. Cruse and T.G. Meyer
Commercial Products Div., Pratt & Whitney Aircraft Group, 400 Main St., East Hartford, CT 06108, J. Engr. Power, Trans. ASME, 101 (4), pp 563-571 (Oct 1979) 17 figs, 4 tables, 7 refs

Key Words: Disks (shapes), Gas turbine engines, Gas turbine blades, Fatigue life, Mathematical models

The objective of a continuing research program is to develop a low cycle fatigue (LCF) damage model which accurately evaluates the life exhaustion of military gas turbine engine disks subjected to complex loading spectra. This paper reports the results of the first phase of the effort and specifically concerns "cold region" disk bolt holes. A simple cycle LCF model is developed which accounts for nonlinear material behavior and the presence of local surface residual stresses due to machining.

80-1071

Natural Frequencies and Modes of Rhombic Mindlin Plates

K.K. Raju and E. Hinton
Vikram Sarabhabi Space Centre, Trivandrum, India, Intl. J. Earthquake Engr. Struc. Dynam., 8 (1), pp 55-62 (Jan/Feb 1980) 3 figs, 12 tables, 14 refs

Key Words: Plates, Skew plates, Natural frequencies, Mode shapes, Mindlin theory, Rotatory inertia effects

The natural frequencies and mode shapes of thin and moderately thick rhombic plates are obtained using a 9-noded Lagrangian quadrilateral isoparametric plate element based on Mindlin's theory. The effects of rotatory inertia are included. Plates with a wide range of skew angles and boundary conditions are considered and wherever possible the present results are compared with earlier published work.

80-1072

Free Vibration of an Orthotropic Elliptical Plate with a Similar Hole

T. Irie and G. Yamada
Faculty of Engrg., Hokkaido Univ., Sapporo, Japan, Bull. JSME, 22 (172), pp 1456-1462 (Oct 1979) 6 figs, 11 refs

Key Words: Plates, Hole-containing media, Free vibration, Ritz method

This paper studies free vibration of an orthotropic elliptical plate with a similar hole at the center by means of the Ritz method using a spline function as an admissible function. The plate is transformed into an annular plate of unit outer radius, the transverse deflection of the plate is written in a series of the products of deflection function of a sectorial beam and trigonometric function of angular co-ordinate, and the frequency equation is derived by the Ritz method. The present method is applied to orthotropic annular plates and elliptical plates with a similar hole at the center; the natural frequencies and the mode shapes being calculated numerically with high accuracies.

80-1073

Resonance Frequencies and Mode Shapes of Elastically Restrained, Prestressed Annular Plates Attached Together by Flexible Cores

S. Chonan
Dept. of Mech. Engrg., Tohoku Univ., Sendai, Japan, J. Sound Vib., 67 (4), pp 487-500 (Dec 22, 1979) 5 figs, 5 refs

Key Words: Plates, Core-containing media, Mode shapes, Resonance frequencies

The free vibrations of annular plates attached together by flexible cores are studied analytically. Both axisymmetric

and non-axisymmetric vibrations are considered. The plates are elastically constrained against rotation at the inner and outer edges. At the same time, the plates are subjected to initial radial tensions. Detailed analysis is worked out for systems consisting of five through two identical plates with identical boundary conditions and a uniform radial tension. General frequency equations and mode shapes are developed.

SHELLS

80-1074

Some Problems in the Dynamics of Layered Spherical Shells

M.J. Frye
Ph.D. Thesis, The Univ. of Manitobe (Canada), (1979)

Key Words: Shells, Spherical shells, Layered materials

This investigation deals with the free vibration of layered spherical shells. The shell material in each layer is considered to be homogeneous and linearly elastic. Both isotropic and transversely isotropic materials are considered. In the first phase of the study, an exact analysis of the non-axisymmetric wave propagation in a layered elastic sphere is presented. In the second phase of this study, a six-mode shell theory which includes the effects of shear deformation, rotatory inertia, and transverse normal strain is developed to determine the natural frequencies of vibration of a layered transversely isotropic spherical shell. In the third phase of this study, the natural frequencies of vibration of a layered transversely isotropic spherical shell are determined using a finite element approach. The investigation concludes with the presentation and discussion of the numerical results of several example problems.

80-1075

Dynamic Buckling of Isotropic and Orthotropic Shallow Spherical Cap with Circular Hole

R.S. Alwar and B.S. Reddy
Dept. of Applied Mechanics, Indian Inst. of Tech., Madras 600 036, India, Intl. J. Mech. Sci., 21 (11), pp 681-688 (1979) 7 figs, 1 table, 13 refs

Key Words: Shells, Spherical shells, Caps (supports), Dynamic buckling, Hole-containing media

The axisymmetric dynamic behavior of clamped isotropic and orthotropic spherical cap with central circular hole under a uniform step pressure of infinite duration is investigated. The critical loads are determined by using the rapidly converging Chebyshev series in a space domain and a Houbolt numerical integration scheme in time domain. Three different cases of openings are investigated and detailed numerical results have been obtained for the isotropic case and two different cases of orthotrophy.

80-1076

Fluid-Structure Interaction Dynamics in Aircraft Fuel Tanks

M.A. Ferman and W.H. Unger
McDonnell Aircraft Co., McDonnell Douglas Corp., St. Louis, MO, J. Aircraft, 16 (12), pp 885-890 (Dec 1979) 11 figs, 9 refs

Key Words: Aircraft, Fuel tanks, Interaction: structure-fluid

The principal focus of this paper is the explanation of the fluid-structure interaction mechanism. A combined analytical and experimental approach is used to describe the process. Formative applications of the concepts to fatigue and flutter are shown, and utilization for hydraulic ram is indicated.

80-1077

Transients in Cylindrical Shells

D.P. Thambiratnam, A.H. Shah, and H. Cohen
Dept. of Civil Engrg., Univ. of Manitoba, Winnipeg, Canada, Intl. J. Earthquake Engr. Struc. Dynam., 8 (1), pp 17-30 (Jan/Feb 1980) 7 figs, 3 tables, 9 refs

Key Words: Shells, Cylindrical shells, Transient response, Impact response (mechanical), Storage tanks, Seismic excitation

The propagation of non-axially symmetric transients in linear, elastic, isotropic and homogeneous cylindrical shells subjected to impulsive boundary loads is treated in this paper. Expressing the displacement components in the form of a Fourier series in the circumferential co-ordinate, the displacement equations of motion are written for each harmonic. The method is illustrated by presenting detailed numerical results pertaining to the influence of earthquake or blast-induced ground excitation on cylindrical tanks.

80-1078

Vibrations of Segmented Cylindrical Shells by a Fourier Series Component Mode Method

S.-D. Chang and R. Greif

Dept. of Mech. Engrg., Tufts Univ., Medford, MA 02155, J. Sound Vib., 67 (3), pp 315-328 (Dec 8, 1979) 12 figs, 2 tables, 15 refs

Key Words: Shells, Cylindrical shells, Component mode analysis, Fourier series

The vibrations of a multi-segment cylindrical shell with a common mean radius are studied. The solution is based on the component mode method coupled with Fourier series and Lagrange multipliers. Results are presented for simply supported shells and clamped-free shells for two segments with different length and thickness.

80-1079

Dynamic Analysis of Shells of Revolution-Soil Systems

O.M. El-Shafee

Ph.D. Thesis, Washington Univ., 228 pp (1979)

UM 800 1220

Key Words: Shells, Shells of revolution, Soils, Interaction: soil-structure, Finite element technique, Mathematical models, Substructure methods

A finite element model has been developed to analyze shells of revolution under dynamic loading with soil-structure interaction effects. The model consists of high-precision rotational shell finite elements, representing the axisymmetric shell, supported on an equivalent boundary system, representing the soil medium. The substructure method is used to model the shell and soil components. The dynamic behavior of a hyperboloidal cooling tower shell on discrete supports with a ring footing is studied using the proposed model. Dynamic properties are studied and stress analysis is carried out for a variety of soil conditions.

80-1080

Analytical Method for Determining Seismic Response of Cooling Towers on Footing Foundations

O. El-Shafee and P.L. Gould

Dept. of Civil Engrg., Washington Univ., St. Louis, MO, Rept. No. NSF/RA-790165, 228 pp (Sept 1979)

PB-301 308/3GA

Key Words: Cooling towers, Footings, Shells of revolution, Interaction: soil-structure, Finite element technique, Mathematical models, Computer programs

A finite element model is developed to analyze shells of revolution under dynamic loading with soil-structure interaction effects. The model consists of high-precision rotational shell finite elements, representing the axisymmetric shell, supported on an equivalent boundary system, representing the soil medium. The substructure method is used to model the shell and soil components. The dynamic behavior of a hyperboloidal cooling tower is studied using the proposed model. Dynamic properties are studied and stress analysis is carried out for a variety of soil conditions. The appendices include high precision rotational shell elements, details of stiffness matrix for an isoparametric solid element, a listing of the SUBASE Program, and modifications and additions for the User's Manual of the SHORE-III Program.

RINGS

(See No. 1062)

PIPES AND TUBES

80-1081

Dynamic Responses of a Pair of Circular Tubes Subjected to Liquid Cross Flow

J.A. Jendrzejczyk, S.S. Chen, and M.W. Wambsganss

Components Tech. Div., Argonne National Lab., Argonne, IL 60439, J. Sound Vib., 67 (2), pp 263-273 (Nov 22, 1979) 11 figs, 17 refs

Key Words: Tubes, Fluid-induced excitation

This paper presents the results of two experimental investigations of a pair of circular tubes subjected to liquid cross flow: two tubes in a plane normal to the flow stream; and two tubes in tandem. Tube response characteristics, including natural frequencies, damping, displacements and vibration orbits, are measured and reported.

80-1082

Flow-Induced Vibration in Shell-and-Tube Heat Exchangers for Ocean Thermal Energy Conversion (OTEC)

J.J. Lorenz and D. Yung

Argonne National Lab., Argonne, IL, Rept. No. ANL-OTEC-78-3, 49 pp (Aug 1978)

N79-30522

Key Words: Heat exchangers, Pipes (tubes), Shells, Fluid-induced excitation

The problem of crossflow-induced vibration in shell-and-tube heat exchangers for OTEC is considered. Models of the dominant excitation mechanisms are discussed: vortex shedding, turbulent buffeting, fluid-elastic instability, and acoustic excitation. Criteria are presented for assessing vibration and equations are derived for predicting the maximum allowable span length as a function of crossflow velocity and other system variables.

80-1083

Lifeline Response Analysis Under Nonstationary Traveling Seismic Wave Loading

S. Pazargadi

Ph.D. Thesis, Stanford Univ., 213 pp (1979)

UM 8001990

Key Words: Lifeline systems, Seismic excitation, Mathematical models, Random vibration, Pipelines, Piping systems, Nuclear reactors

The main objective of this dissertation is to develop a random vibration model of an above-the-ground lifeline system under nonstationary Gaussian traveling surface wave loading and subsequently to study the wave passage effects on the response behavior of the system.

80-1084

Research on Wave Phenomena in Hydraulic Lines (6th Report, Transient Properties of Non-linear Elements)

S. Washio, T. Konishi, and Y. Miyazawa

Faculty of Engrg., Kyoto Univ., Sakyo-ku, Kyoto, Japan, Bull. JSME, 22 (172), pp 1399-1406 (Oct 1979) 22 figs, 6 refs

Key Words: Hydraulic systems, Pipelines, Fluid-induced excitation

A new method is presented which gives complete plots of transient waves in hydraulic pipes with non-linear boundaries. The availability of the method is confirmed in an experiment to observe dispersions of pressure pulses by an air bubble placed in an oil pipe.

DUCTS

(Also see No. 1024)

80-1085

The Effects of External Lagging on Low Frequency Sound Transmission Through the Walls of Rectangular Ducts

A. Cummings

Inst. of Environmental Science and Tech., Polytechnic of the South Bank, London SE1 OAA, UK, J. Sound Vib., 67 (2), pp 187-201 (Nov 22, 1979) 9 figs, 7 refs

Key Words: Rectangular ducts, Ducts, Acoustic absorption, Sound transmission, Noise reduction, Walls

This paper presents an investigation of the effects of external "lagging" (consisting of a layer of porous sound-absorbing material, and an impervious external covering) on the duct walls; this type of treatment is commonly applied as a noise control measure. A simple theoretical model, based on a coupled acoustic/structural wave system, is devised.

80-1086

Acoustic Plane Waves Normally Incident on a Clamped Panel in a Rectangular Duct

H. Unz and J. Roskam

Kansas Univ. Ctr. for Research, Inc., Lawrence, KS, Rept. No. NASA-CR-162278, KU-FRL-417-11, 130 pp (Aug 1979)

N79-32055

Key Words: Rectangular ducts, Ducts, Panels, Fundamental frequency

The theory of acoustic plane wave normally incident on a clamped panel in a rectangular duct is developed. The coupling theory between the elastic vibrations of the panel (plate) and the acoustic wave propagation in infinite space and in the rectangular duct is considered. The partial differential equation which governs the vibration of the panel (plate) is modified by adding to its stiffness (spring) forces and damping forces, and the fundamental resonance frequency and the attenuation factor are discussed.

80-1087

A Geometric Acoustics Approach to the Study of Sound Propagation in Ducts Containing Sheared Flows

D.W. Grimm and C.J. Hurst

Proctor and Gamble Co., Cincinnati, OH 45224, J. Acoust. Soc. Amer., 66 (6), pp 1867-1875 (Dec 1979) 14 figs, 22 refs

Key Words: Ducts, Sound propagation

Geometric acoustics have been used to study the propagation of sound waves in a homogeneous moving medium with sheared flow bounded by the hard walls of a duct. Differential equations describing the ray trajectories and the spreading losses along each ray are developed and solved numerically for a range of centerline Mach numbers and shear boundary-layer thicknesses. A method is also developed to allow the calculation of intensity loss profiles at specified downstream cross sections of the duct.

80-1088

Acoustic Synthesis of a Flowduct Area Discontinuity

R.F. Lambert and E.A. Steinbrueck

Dept. of Electrical Engrg., Univ. of Minnesota, Minneapolis, MN 55455, J. Acoust. Soc. Amer., 67 (1), pp 59-65 (Jan 1980) 6 figs, 9 refs

Key Words: Ducts, Acoustic reflection, Geometric effects

An experimental study of the acoustic pressure reflection coefficient at a sudden area expansion in a flowduct in regard to both magnitude and phase is undertaken. The magnitude of the coefficient is flow dependent and relatively insensitive to frequency while the phase is frequency dependent and relatively independent of flow. A semi-empirical analytical model is synthesized on the basis of available information that incorporates both frequency characteristics and flow affects through second order in the Mach number.

80-1089

The Influence of Grazing Flow on the Acoustic Impedance of a Cylindrical Wall Cavity

M.S. Howe

Bolt Beranek and Newman, Inc., 50 Moulton St., Cambridge, MA 02138, J. Sound Vib., 67 (4), pp 533-544 (Dec 22, 1979) 5 figs, 14 refs

Key Words: Ducts, Cavity-containing media, Acoustic impedance

The acoustic impedance at low frequencies of a circular cylindrical cavity in the wall of a duct in the presence of a low Mach number mean flow is examined. A linearized theoretical model is proposed which involves the unsteady shedding of vorticity from the upstream edge of the cavity aperture. Certain difficulties associated with the linearized treatment of cavity oscillations are also discussed.

80-1090

Interaction of Induced Sound with Flow Past a Square Leading Edged Plate in a Duct

M.C. Welsh and D.C. Gibson

Div. of Mech. Engrg., Commonwealth Scientific Industrial Res. Organization, Melbourne, Australia, J. Sound Vib., 67 (4), pp 501-511 (Dec 22, 1979) 9 figs, 14 refs

Key Words: Ducts, Plates, Acoustic resonance, Vortex shedding

The interaction of resonant sounds with the flow past a thick, blunt, flat plate in a rigid walled square duct is examined.

80-1091

Experimental and Numerical Results on a Shear Layer Excited by a Sound Pulse

L. Maestrello, A. Bayliss, and E. Turkel

NASA Langley Research Ctr., Hampton, VA, Rept. No. NASA-TM-80183, 47 pp (Nov 1979) N80-12821

Key Words: Sound attenuation

The behavior of a sound in a jet is investigated. The connection between this amplification and the local instability waves is discussed.

BUILDING COMPONENTS

(Also see No. 1117)

80-1092

Response of Masonry Walls to Blast Loading: A Discrete Element Analysis

T.M. Al-Aswad

Ph.D. Thesis, Oklahoma State Univ., 177 pp (1979) UM 7928190

Key Words: Walls, Masonry, Blast response, Computer programs

A model is developed to simulate the behavior of solid, unreinforced masonry walls under blast loading. The wall is modeled as a system of rigid blocks connected by three-dimensional linkage elements. Each linkage element is composed of three perpendicular springs, with stiffnesses depending on mortar and masonry block properties and block dimensions. Walls with horizontal stack and running bond patterns are studied, with clay bricks or concrete blocks as masonry units. A computer program is written in FORTRAN language for solving the equations of motion by Newmark's method.

80-1093

Measures of Ductility for Structural Walls in Earthquake-Resistant Multistory Buildings

S.K. Ghosh, M. Iqbal, A.T. Derecho, and M. Fintel
Portland Cement Assn., Skokie, IL, Rept. No. NSF/RA-780209, 12 pp (Jan 1978)
PB-300 387/8GA

Key Words: Walls, Buildings, Multistory buildings, Earthquake-resistant structures, Computer programs

This paper attempts to establish, for the particular case of slender structural walls subject predominantly to flexure, a relationship among displacement, rotational and curvature ductilities which refer to an entire structure, to critical regions within a structure, and to critical sections within those regions, respectively. The relationships are developed on the basis of a simplified model. Limited results correlating displacement and rotational ductilities, and based on actual seismic analyses of isolated structural walls, are presented.

80-1094

Frequency Content, Intensity and Yield Level in Nonlinear Dynamic Response

A.T. Derecho, M. Iqbal, S.K. Ghosh, and M. Fintel
Portland Cement Assn., Skokie, IL, Rept. No. NSF/RA-780123, 12 pp (Jan 1978)
PB-300 909/9GA

Key Words: Earthquakes, Walls, Nonlinear response, Earthquake response

Three major parameters characterizing earthquake motions affect structural response. These include intensity, duration, and frequency content. In this paper, an attempt is made to characterize input motions in terms of frequency content on the basis of their 5%-damped velocity response spectra as peaking and broad band. Results of analyses for isolated structural walls having different fundamental period and yield level are presented.

80-1095

Earthquake Induced Deformations in Reinforced Earth Walls

W.E. Wolfe
Ph.D. Thesis, Univ. of California, Los Angeles, 297 pp (1979)
UM 8001419

Key Words: Walls, Earth structures, Retaining walls, Earthquake damage, Simulation

The behavior of reinforced earth retaining walls under both static loads and during simulated earthquake base motions is studied. Laboratory tests are performed on model walls varying in height up to a maximum of two feet.

80-1096

Hysteretic Behavior of R/C Structural Walls

J.M. Vallenas
Univ. of California, Berkeley, 479 pp (1979)
UM 8000554

Key Words: Walls, Reinforced concrete, Earthquake response, Simulation

The problem of understanding and modeling the behavior of reinforced concrete structural walls subjected to high shear earthquake loading conditions is studied. Results of eight earthquake simulation tests on 1/3 scale structural R/C wall subassemblage model specimens are presented. Details of the test set up, the models tested, and the test procedure are summarized. The main experimental results are evaluated in terms of the hysteretic characteristics (strength, deformation and energy dissipation capacity), modes of failure, ease of construction, and effectiveness of repair.

80-1097

Experimental Study of Frame-Wall Interaction in Reinforced Concrete Structures Subjected to Strong Earthquake Motions

D.P. Abrams and M.A. Sozen

Dept. of Civil Engrg., Illinois Univ. at Urbana-Champaign, IL, Rept. No. STRUCTURAL RESEARCH SER-460, UILU-ENG-79-2002, NSF/RA-790132, 400 pp (May 1979)
PB-301 091/5GA

Key Words: Buildings, Walls, Frames, Reinforced concrete, Concretes, Earthquake resistant structures, Earthquake response, Experimental data

A better understanding of the response of frame-wall structures to strong earthquake motions is developed. Measurements at each of the ten levels included accelerations, displacements and forces resisted by the interior wall. Experimental parameters of the four-structure series were the simulated earthquake motion and the strength of structure.

80-1098

Infill Panels: Their Influence on Seismic Response of Buildings

J.W. Axley
Ph.D. Thesis, Univ. of California, Berkeley, 192 pp (1979)
UM 8000273

Key Words: Buildings, Seismic response, Panels, Frames

The problem of modeling the stiffness contribution of infill panels to elastic frame-infill systems is discussed. A set of dimensionless parameters is developed that is sufficient to define the nature of this stiffness contribution. A means to model the structural behavior of frame-infill systems is proposed.

80-1099

Cyclic Loading Tests of Masonry Single Piers. Volume 3. Height to Width Ratio of 0.5

P.A. Hidalgo, R.L. Mayes, H.D. McNiven, and R.W. Clough
Earthquake Engrg. Research Ctr., California Univ., Richmond, CA, Rept. No. UCB/EERC-79/12, NSF/RA-790185, 154 pp (May 1979)
PB-301 321/6GA

Key Words: Buildings, Piers, Masonry, Cyclic loading, Experimental data, Seismic response

This report presents the results of eighteen cyclic, in-plane shear tests on fixed ended masonry piers having a height to width ratio of 0.5. These eighteen tests form part of a test program consisting of eighty single pier tests. The test setup was designed to simulate, insofar as possible, the boundary conditions the piers would experience in a perforated shear wall of a complete building. The results are presented in the form of hysteresis envelopes, graphs of stiffness degradation, energy dissipation and shear distortion, and tabulated data on the ultimate strength and hysteresis indicators.

80-1100

Acceptability Criterion for Occupant-Induced Floor Vibrations

T.M. Murray
The Univ. of Oklahoma, Norman, OK, S/V, Sound Vib., 13 (11), pp 24-30 (Nov 1979) 4 figs, 27 refs

Key Words: Floors, Vibration damping

Various scales for determining the acceptability of steel beam- and steel joist-concrete slab floor systems subject to occupant-induced floor vibrations are reviewed and compared. A new criterion, based on experimental results from ninety-one floor systems is presented.

80-1101

Seismic Behavior of Reinforced Concrete Interior Beam-Column Subassemblages

S. Viwathanatepa, E.P. Popov, and V.V. Bertero
Earthquake Engrg. Research Ctr., California Univ., Richmond, CA, Rept. No. UCB/EERC-79/14, NSF/RA-790186, 201 pp (June 1979)
PB-301 326/5GA

Key Words: Structural members, Buildings, Beams, Columns, Reinforced concrete, Concrete, Seismic response, Earthquake resistant structures

This report gives details of experiments to test the seismic behavior of reinforced concrete subassemblages carried out on beam-column subassemblages, and evaluates the significance of the analytical and experimental results obtained. Two virgin concrete subassemblages and one repaired subassemblage were tested.

ELECTRIC COMPONENTS

MOTORS

80-1102
Controlling Noise from Electrical Equipment
J.M. Guinter
Experimental Engineering Delco Products Div., General Motors Corp., Dayton, OH, Noise Control Engr., 13 (3), pp 129-144 (Nov/Dec 1979) 8 figs, 8 tables, 57 refs

Key Words: Electrical machines, Noise reduction

Electrical devices which transform and control energy or drive machines also add noise to the surroundings. The mechanisms which generate noise and the noise characteristics of several types of electrical equipment are reviewed. Suggestions are offered for selecting quiet equipment, and for identifying and correcting the causes of equipment noises.

DYNAMIC ENVIRONMENT

ACOUSTIC EXCITATION

(Also see Nos. 961, 962, 971, 989, 992, 999, 1000 1001, 1002, 1007, 1008, 1045, 1085, 1087, 1090 1091, 1155, 1167, 1218, 1230, 1233, 1234)

80-1103
Diffraction of Ultrasonic Waves by Penny-Shaped Cracks in Metals: Theory and Experiment
J.D. Achenbach, L. Adler, D.K. Lewis, and H. McMaken
The Technological Inst., Northwestern Univ., Evanston, IL 60201, J. Acoust. Soc. Amer., 66 (6), pp 1848-1856 (Dec 1979) 16 figs, 1 table, 16 refs

Key Words: Acoustic scattering, Cracked media, Discontinuity containing media

In this paper an analytical solution to the diffraction of elastic waves by penny-shaped cracks in metals is compared with experimental observations. A digitized spectrum analysis system is described which measures the frequency components of the waves diffracted from a crack in diffusion bonded titanium.

80-1104
Direct and Inverse Problems in Radiation of Sound from Discrete Random Sources on Two Coaxial Rings
L. Maestrello
NASA Langley Research Ctr., Hampton, VA 23665, J. Acoust. Soc. Amer., 66 (6), pp 1876-1890 (Dec 1979) 12 figs, 3 tables, 14 refs

Key Words: Sound waves, Rings

An analytical model consisting of two ring sources of sound is developed to study the direct radiation in terms of correlation, coherence, and phase and also to aid in solving the inverse-radiation problem of determining the noise source in terms of farfield measurements. The rings consist of discrete sources which are either monopoles or quadrupoles with Gaussian autocorrelations. Only adjacent sources, both within and between the rings, are correlated.

80-1105
Acoustic Emission: An Application to Fracture Mechanics
R.K. Miller
Ph.D. Thesis, Purdue Univ., 156 pp (1979)
UM 7926413

Key Words: Acoustic emission, Fracture properties

This research is an attempt to develop a practical theory for analyzing the acoustic emissions from various engineering materials. An experimental system used to detect and record acoustic emissions has been created in order to validate the proposed theory. Categorically, this research consists of three major parts. The first part involves the development of the experimental system. The second part of this thesis proposes a new theory relating acoustic emissions from Double-Edge-Cracked (DEC) plates to the stress intensity factor and the crack length. The third part of this thesis compares experimental results and theoretical predictions.

80-1106

Multipath Interference Nulls in Long-Range, Low-Frequency, Acoustic Propagation by Normal Modes

D.F. Gordon

Naval Ocean Systems Ctr., San Diego, CA 92152, J. Acoust. Soc. Amer., 67 (1), pp 106-120 (Jan 1980) 19 figs, 13 refs

Key Words: Sound propagation, Normal modes

Several aspects of multipath interference beats are investigated by analyzing long-range propagation losses computed by normal mode theory. Three typical deep water sound-speed profiles are used at frequencies of 100 Hz and below.

80-1107

Propagation of Sound Through the Atmosphere: Effects of Ground Cover II

H.E. Bass and L.N. Bolen

Physical Acoustics Research Group., Mississippi Univ., University, MS, Rept. No. PARGUM-79-01, ARO-14002.2-EX, 55 pp (June 30, 1979)
AD-A073 262/8GA

Key Words: Sound propagation, Sound transmission, Acoustic impedance

Measurements of sound amplitude in the vicinity of a ground plane are made as a function of frequency of the sound source (50 Hz - 2000 Hz), distance of propagation (5m - 300m), and surface conditions.

80-1108

Resonance Theory of Acoustic Waves Interacting with an Elastic Plate

R. Fiorito, W. Madigosky, and H. Uberall

Naval Surface Weapons Ctr., White Oak Lab., Silver Spring, MD 20910, J. Acoust. Soc. Amer., 66 (6), pp 1857-1866 (Dec 1979) 11 figs, 26 refs

Key Words: Sound transmission, Sound reflection, Plates

Sound transmission and reflection properties of an elastic layer immersed in a fluid are analyzed by extending the resonance formalism. Resonance expressions for the transmission and reflection coefficients are obtained both in terms of the frequency-thickness variable and of the angle-of-incidence variable. The resonance positions and widths are explicitly obtained from real equations in terms of given material quantities. Comparison of the resonance theory and exact calculations are given for a steel plate immersed in water.

80-1109

Acoustic Analysis of the Propfan

F. Farassat and G.P. Succi

George Washington University, VA, Rept. No. NASA-CR-162312, 42 pp (1979)
N79-32210

Key Words: Propeller noise, Noise prediction, Computer programs, Time domain method

A review of propeller noise prediction technology is presented. Two methods for the prediction of the noise from conventional and advanced propellers in forward flight are described. These methods are based on different time domain formulations. Brief descriptions of the computer algorithms based on these formulations are given.

80-1110

Vibroacoustical Detection and Identification of Cavity Formations (Vibroakustische Detektion und Identifizierung von Kavitationserscheinungen)

K. Jahn

Technische Universitat Dresden, Sektion Energieumwandlung, Bereich Stromungstechnik Bereichsleiter, Maschinenbautechnik, 27 (6), pp 272-276 (June 1978) 9 figs, 10 refs
(In German)

Key Words: Cavitation noise, Vibratory techniques, Acoustic techniques

Cavitation and spectral distribution of cavitation noise in a cavitation channel are measured. The cavitation formation is detected by means of vibroacoustic techniques. Critical cavitation coefficients fcr circular cylinders and prisms are given. The cavitation is identified using generalizations derived from the measured spectra.

80-1111

A Fundamental Study on Frictional Noise (1st Report, The Generating Mechanism of Rubbing Noise and Squeal Noise)

M. Yokoi and M. Nakai

Jr. College, Osaka Industrial Univ., Osaka, Japan, Bull. JSME, 22 (173), pp 1665-1671 (Nov 1979) 11 figs 12 refs

Key Words: Noise generation, Friction excitation

The generating mechanism of frictional noise in dry friction is experimentally and theoretically studied when a contact rod clamped at one end is pressed in the radial direction on a rotating disk.

80-1112

Eigenmodes in Nonrectangular Reverberation Rooms

J.M. van Nieuwland and C. Weber

Philips Res. Laboratories, Eindhoven, The Netherlands, Noise Control Engr., 13 (3), pp 112-121 (Nov/Dec 1979) 10 figs, 17 refs

Key Words: Reverberation chambers, Resonant frequencies, Modal superposition method, Finite element technique

Eigenmodes in nonrectangular reverberation rooms are studied.

80-1113

On the Multiple Scattering of Waves from Obstacles with Solid-Fluid Interfaces

B. Peterson, V.V. Varadan, and V.K. Varadan

Ohio State Univ. Research Foundation, Columbus, OH, 29 pp (July 1979)

AD-A074 057/1

Key Words: Elastic waves, Wave diffraction

The purpose of this article is to present a T-matrix formalism for elastic wave scattering by multi-layered regions with solid-fluid interfaces.

80-1114

Effect of Grazing Flow on the Acoustic Impedance of Helmholtz Resonators Consisting of Single and Clustered Orifices

A.S. Hersch and B. Walker

Hersch Acoustical Engrg., Chatsworth, CA, Rept. No. NASA-CR-3177, 183 pp (Aug 1979)

N79-32056/0

Key Words: Helmholtz resonators, Acoustic impedance

A semiempirical fluid mechanical model is derived for the acoustic behavior of thin-walled single orifice Helmholtz resonators in a grazing flow environment. The incident and cavity sound fields are connected in terms of an orifice discharge coefficient whose values are determined experimentally using the two-microphone method.

80-1115

Digital Wavefront Reconstruction for Acoustical Applications

R.L. Cohen

Applied Research Lab., Pennsylvania State Univ., University Park, PA, Rept. No. ARL/PSU/TM-79-132, 226 pp (July 12, 1979)

AD-A073 775/9GA

Key Words: Noise source identification, Acoustic holography, Holographic techniques, Plates, Data display

The work presented is an extension of research in acoustical holography as a tool for sound source location; this research being centered on digital processing and computer graphics imaging.

80-1116

Jet Noise Diagnostics: Spurious Sound Generated by Hot-Wire Turbulence Interaction

W.G. Richarz

Univ. of Toronto, Inst. for Aerospace Studies, 4925 Dufferin St., Downsview, Ontario, Canada, J. Acoust. Soc. Amer., 67 (1), pp 73-77 (Jan 1980) 4 figs, 14 refs

Key Words: Jet noise, Noise source identification

The present analysis predicts the effects of probe noise on measured cross correlations and cross-spectral densities. The description relies on Ribner's self and shear noise model, a development of Lighthill's theory of jet noise. Predictions are supported by jet noise-jet flow correlations measured with a hot wire and with a nonintrusive device: a Laser Doppler Velocimeter (LDV).

80-1117

Acoustic Wave Propagation in Bent Thin-Walled Wave Guides

G. Rosenhouse
Faculty of Civil Engrg., Technion-Israel Inst. of Tech., Haifa 32000, Israel, J. Sound Vib., 67 (4), pp 469-486 (Dec 22, 1979) 13 figs, 5 tables, 9 refs

Key Words: Sound attenuation, Waveguide analysis, Noise reduction, Structural members, Walls, Beams, Plates

The attenuation due to folding of the structure is compared to the damping effect of the material. A pair of examples of insulation analysis of structures is worked out. The influence of dense columns in walls, of beams in plates, and of coupling effects in bent structures are examined.

80-1118

Viscous Attenuation of Sound in Saturated Sand

J.M. Hovem and G.D. Ingram
Applied Research Labs., The Univ. of Texas at Austin, TX 78712, J. Acoust. Soc. Amer., 66 (6), pp 1807-1812 (Dec 1979) 6 figs, 16 refs

Key Words: Sound attenuation, Sand, Soils

Based on Biot's theory for the propagation of sound in a fluid-saturated porous medium, the viscous attenuation of sound is studied both theoretically and experimentally.

80-1119

Estimation of Noise Shielding by Barriers

Engineering Sciences Data Unit Ltd., London, UK, Rept. No. ISBN-0-85679-255-1, 41 pp (1979) ESDU-79011

Key Words: Noise barriers, Noise reduction

This item is concerned with the sound reaching the observer via the edge of the barrier. A method is provided for estimating the shielding effect of a barrier in terms of the difference in sound level received at a given location on the side of the barrier remote from the noise source and the sound level received at the same location without the barrier.

80-1120

Measuring the Radiating Height of Vehicles for Calculating the Effectiveness of Sound Barriers

R.N. Foss
Applied Physics Lab., Univ. of Washington, 1013 NE 40th, Seattle, WA 98105, Noise Control Engr., 13 (3), pp 122-128 (Nov/Dec 1979) 10 figs, 2 refs

Key Words: Noise barriers, Walls, Traffic noise

A series of measurements undertaken to determine the effective radiation height and frequency spectrum of a wide variety of cars and trucks is described.

80-1121

Line Integral Theory of Barrier Attenuation in the Presence of the Ground

T.F.W. Embleton
Div. of Physics, National Research Council, Ottawa, Ontario, Canada K1A OR6, J. Acoust. Soc. Amer., 67 (1), pp 42-45 (Jan 1980) 2 figs, 8 refs

Key Words: Noise barriers, Acoustic diffraction

A theory of diffraction is presented that is based on the line integral along the free edge of a semi-infinite barrier. Expressions, which are not integrable analytically, are given for the cases where the source/receiver line is and is not perpendicular to the edge of the barrier.

80-1122

Noise Reduction by Barriers on Finite Impedance Ground

T. Isei, T.F.W. Embleton, and J.E. Piercy
Usui Laboratory, Kyushu Branch, National Research Inst. for Pollution and Resources, 1142 Nishinogo, Usui-cho, Kaho-gun, Fukuoka, 820-05, Japan, J. Acoust. Soc. Amer., 67 (1), pp 46-58 (Jan 1980) 14 figs, 2 tables, 35 refs

Key Words: Noise barriers, Acoustic diffraction, Mathematical models

The sound field due to a point source behind a barrier on ground of finite impedance is calculated from five theories that differ mainly in their theoretical approach to diffraction and the model for ground impedance. These predicted values for the sound field are compared with results measured out-

doors using plywood barriers on different combinations of hard and soft ground. Each of these theories allows for interference due to differences between several paths of propagation, determined by the geometry of the source, receiver, barrier, and ground.

80-1123

An Examination of Coupled Mode Theory as Applied to Underwater Sound Propagation

S.R. Rutherford

Ph.D. Thesis, The Univ. of Texas at Austin, 217 pp (1979)

UM 7928353

Key Words: Underwater sound, Sound propagation, Modal analysis, Approximation methods, Numerical analysis

The work presented in this dissertation is a theoretical investigation of the mathematical formalism of coupled mode theory as applied to underwater sound propagation in a range dependent, ocean environment. The range dependence of an acoustic medium may be characterized by two types, range variability of the geoacoustic parameters such as sound speed and range variability of the boundary conditions. This dissertation focuses on both types of range variation and examines coupled mode theory and its various approximations with respect to the range variability of the ocean bottom.

80-1124

A Plane-Wave Reflection Loss Model Including Sediment Rigidity

P.J. Vidmar and T.L. Foreman

Applied Res. Labs., The Univ. of Texas at Austin, TX 78712, J. Acoust. Soc. Amer., 66 (6), pp 1830-1835 (Dec 1979) 3 figs, 1 table, 23 refs

Key Words: Underwater sound, Sound reflection

A method is presented for computation of the complex plane-wave reflection coefficient of an acoustic wave impinging upon a horizontally stratified ocean bottom consisting of a single inhomogeneous (fluid or solid) sediment layer overlying a semi-infinite homogeneous (fluid or solid) substrate. Within the sediment layer the density, the compressional wave speed and attenuation, and the shear wave speed and attenuation are permitted to vary arbitrarily and independently. A matrix formulation is used in which the depth-seperated wave equations are replaced by the "propagator" matrix. The elements of the propagator are calculated by numerical integration of the Helmholtz equations with depth-dependent wavenumbers.

80-1125

Acoustic Reflection from a Sea Bottom with Linearly Increasing Sound Speed

A.O. Williams, Jr. and D.R. MacAyeal

Brown Univ., Providence, RI 02912, J. Acoust. Soc. Amer., 66 (6), pp 1836-1841 (Dec 1979) 10 refs

Key Words: Underwater sound, Sound reflection

The acoustic reflection coefficient for plane waves, in a homogeneous fluid half-space, incident at arbitrary angle upon an underlying half-space of unconsolidated bottom sediments are calculated. The lower half-space, treated here as a fluid, has constant density and a sound speed that increases linearly with depth. An exact formal expression is found for the complex reflection coefficient R, in terms of a modified Bessel function.

80-1126

Long-Range, Deep-Ocean Propagation of 15-Hz CW Acoustic Signals

R. Fitzgerald, J.D. Shaffer, A.N. Guthrie, D.A. Nutile, and W.R. Hahn

Naval Research Lab., Washington, D.C., Rept. No. NRL-8302, AD-E000 315, 22 pp (Aug 9, 1979)

AD-A073 348/5GA

Key Words: Underwater sound, Sound transmission

The acoustic field of a shallow continuous-wave source operating near 15-Hz is measured at a deep sound-channel hydrophone located near Midway Island. The source is towed repeatedly between 700-km range and 1700-km range along a great circle track whose extension passes through the receiver.

80-1127

Some Underwater Propagation Studies in the Vicinity of the NOSC Oceanographic Tower

J. Northrop

Naval Ocean Systems Ctr., San Diego, CA, Rept. No. NOSC/TR-424, 42 pp (June 1979).

AD-A073 492/1GA

Key Words: Underwater sound, Sound transmission

Low-frequency underwater sound transmission studies were made to a range of 81 km west of the NOSC oceanographic tower off Mission Beach, San Diego, California. Both explosive and CW sources were used to ranges of 26 km, and explosive sources to longer ranges. Both hydrophones and three-component geophones were used as detectors.

80-1128

Mode Interactions in an Isovelocity Ocean of Uniformly Varying Depth

A.O. Williams, Jr.

Brown Univ., Providence, RI, J. Acoust. Soc. Amer., 67 (1), pp 177-185 (Jan 1980) 1 fig, 8 refs

Key Words: Underwater sound, Sound propagation

Pierce's treatment of normal-mode propagation for an ocean in which physical parameters vary slowly with range is used to calculate mode interactions for isovelocity water of depth varying linearly with range.

80-1129

A Review of Deep Ocean Sound Attenuation Data at Very Low Frequencies

A.C. Kobblewhite and L.D. Hampton

Dept. of Physics, Univ. of Auckland, Auckland, New Zealand, J. Acoust. Soc. Amer., 67 (1), pp 147-157 (Jan 1980) 9 figs, 1 table, 34 refs

Key Words: Underwater sound, Sound attenuation

The behavior of the attenuation coefficient at very low frequencies (below 200 Hz) has been clouded by the unexplained scatter in experimental data. An attempt is made here to review all the relevant data and to achieve some rational grouping in terms of such regional effects.

80-1130

Theoretical and Numerical Green's Function Field Solution in a Plane Multilayered Medium

F.R. DiNapoli and R.L. Deavenport

New London Lab., Naval Underwater System Ctr., New London, CT 06320, J. Acoust. Soc. Amer., 67 (1), pp 92-105 (Jan 1980) 5 figs, 1 table, 29 refs

Key Words: Layered materials, Underwater sound, Mathematical models

An explicit general form is derived for the depth-dependent Green's function occurring in the integral solution to the Helmholtz wave equation for range-independent layered media. This representation permits arbitrary location of the source and receiver. In addition, a technique, the Fast Field Program (FFP), for the evaluation of the integral solution is delineated. Examples of the use of both the formulation and the FFP to the problem of modeling underwater acoustic propagation loss versus range, where the source/receiver are in air/water, in water/bottom, and in a cross-layer surface duct, are discussed.

SHOCK EXCITATION

(Also see Nos. 948, 959, 969, 975, 978, 980, 981, 991, 1013, 1015, 1016, 1019, 1054, 1083, 1095, 1096, 1097, 1098, 1179, 1190, 1222, 1223, 1235, 1236)

80-1131

Simulation of Strong Earthquake Motion with Contained-Explosive Line Source Arrays, Single-Source and Array Tests at Camp Parks

J.R. Bruce, H.E. Lindberg, and G.R. Abrahamson

SRI International, Menlo Park, CA, Rept. No. NSF/RA-790129, 75 pp (Mar 1979)

PB-301 096/4GA

Key Words: Earthquake resistant structures, Interaction: soil-structure, Simulation, Model testing

An earthquake simulation technique to aid in the design of earthquake resistant structures is reported. In-situ structures are tested to observe vibration modes and explore potential damage mechanisms in complete soil-structure and internal equipment systems.

80-1132

Impacting Under Harmonic Excitation

G.S. Whiston

Central Electricity Research Labs., Kelvin Ave., Leatherhead KT22 7SE, UK, J. Sound Vib., 67 (2), pp 179-186 (Nov 22, 1979) 4 figs, 2 refs

Key Words: Oscillators, Harmonic excitation, Periodic response, Wear, Mechanical components

The steady state response of a one dimensional linear oscillator impacting under harmonic excitation on to rigid obstructions with a coefficient of velocity restitution is investigated. Numerical experiments are discussed and an expression of the steady state velocity for one sided impacting is derived. The variation of impacting velocity with excitation frequency for symmetric two sided impacting steady states is analyzed.

80-1133

Off-Axis Impact of Unidirectional Composites with Cracks: Dynamic Stress Intensification

G.C. Sih and E.P. Chen

Inst. of Fracture and Solid Mechanics, Lehigh Univ., Bethlehem, PA, Rept. No. NASA-CR-159537, IFSM-79-95, 65 pp (Jan 1979)

N79-30294

Key Words: Composite materials, Impact response (mechanical)

The dynamic response of unidirectional composites under off axis (angle loading) impact is analyzed by assuming that the composite contains an initial flaw in the matrix material. The analytical method utilizes Fourier transform for the space variable and Laplace transform for the time variable. The off axis impact is separated into two parts, one being symmetric and the other skew-symmetric with reference to the crack plane. Transient boundary conditions of normal and shear tractions are applied to a crack embedded in the matrix of the unidirectional composite. The two boundary conditions are solved independently and the results superimposed.

80-1134

Normal and Radial Impact of Composites with Embedded Penny-Shaped Cracks

G.C. Sih

Inst. of Fracture and Solid Mechanics, Lehigh Univ., Bethlehem, PA, Rept. No. NASA-CR-159538, IFSM-79-99, 54 pp (Feb 1979)

N79-31627/9

Key Words: Layered materials, Composite materials, Fiber composites, Cracked media, Discontinuity-containing media, Impact tests

A method is developed for the dynamic stress analysis of a layered composite containing an embedded penny-shaped crack and subjected to normal and radial impact. The material properties of the layers are chosen such that the crack lies in a layer of matrix material while the surrounding material possesses the average elastic properties of a two-phase medium consisting of a large number of fibers embedded in the matrix.

80-1135

Simulation Development for Target Assessment. Part II.

J.A. Earickson

Eric H. Wang Civil Engrg. Research Facility, New Mexico Univ., Albuquerque, NM, Rept. No. AFWL-TR-78-158-PT-2, AD-E200 307, 187 pp (Mar 1979)

AD-A071 522/7GA

Key Words: Nuclear explosions, Simulation

This effort produced design information and experimental data for improving high explosive simulation of nuclear airblasts. Specifically, a peak pressure versus charge density relationship for Iremite in 100 percent foam cavities was obtained for pressure up to 68 MPa. The results of this effort were transmitted to USAE Waterways Experiment Station. WES is conducting tests on generic silos as part of a DNA targeting research and test program.

80-1136

Simulation Development for Target Assessment. Part III.

J.A. Earickson

Eric H. Wang Civil Engrg. Research Facility, New Mexico Univ., Albuquerque, NM, Rept. No. AFWL-TR-78-158-PT-3, AD-E200 308, 168 pp (Mar 1979)

AD-A071 523/5GA

Key Words: Nuclear explosions, Simulation

This effort produced design information and experimental data for improving high explosive simulation of nuclear airblasts. Specifically, a peak pressure versus charge density relationship for Iremite in 100 percent foam cavities was obtained for pressure up to 68 MPa. The results of this effort were transmitted to USAE Waterways Experiment Station. WES is conducting tests on generic silos as part of a DNA targeting research and test program.

80-1137

Soil Structure Interaction in Different Seismic Environments

A. Gomez-Masso, J. Lysmer, J. Chen, and H.B. Seed

Earthquake Engrg. Research Ctr., California Univ., Richmond, CA, Rept. No. UCB/EERC-79/18, NSF/RA-790240, 57 pp (Aug 1979)

PB80-101520

Key Words: *Interaction: soil-structure, Seismic response,* Finite element technique, Viscoelasticity

The current strong interest in nuclear power and the concerns regarding the seismic safety of the facilities involved has generated the development of improved methods of seismic soil-structure interaction analysis. Presented is a plane-strain method for soil-structure interaction analysis consisting of the superposition of the free field motions and the interaction motions, in a generalized seismic environment.

VIBRATION EXCITATION

(Also see Nos. 1132, 1147, 1158, 1180, 1197, 1224)

80-1138

Modification of Eigenvalues in Proportionally Damped Vibrational Systems (Beeinflussung der Eigenwerte von Schwingungssystemen mit modaler Dämpfung)

J. Schneider

Lehrstuhl f. Mechanik und Festigkeitslehre im Mechanikzentrum der TU Braunschweig, Pockelsstrasse 4, D-3300 Braunschweig, Bundesrepublik Deutschland, Ing. Arch., 48 (6), pp 393-401 (1979) 11 figs, 2 tables, 6 refs

(In German)

Key Words: Eigenvalue problems, Vibrating structures

The determination of the characteristic behavior of a discrete or a continuous system is simplified if the exact or approximate proportionality of the individual operators of the differential equation are known. The knowledge of proportionality constants allows the judgement of the behavior of original problem from the eigenvalues of a simplified system. System modification criteria are presented in a diagram which shows the desired response of the system, e.g. stability, oscillation, creep, etc.

80-1139

The Use of Moment Equations for Calculating the Mean Square Response of a Linear System to Non-Stationary Random Excitation

M. Sakata and K. Kimura

Dept. of Physical Engrg., Tokyo Inst. of Tech., Tokyo, Japan, J. Sound Vib., 67 (3), pp 383-393 (Dec 8, 1979) 7 figs, 14 refs

Key Words: Random excitation, Linear systems

The moment equations approach is used to calculate the mean square response of a linear system to non-stationary random excitation which is expressed as a product of a deterministic envelope function and a Gaussian stationary non-white noise. The moment equations are derived by performing single integrations in the time domain and are solved numerically by digital computer. Numerical examples are given for the response of single and two degree-of-freedom systems which are excited by noise with an exponentially decaying harmonic correlation function.

80-1140

Determination of Nonlinear and Antisymmetric Spring-Damper-Characteristic Surface (Bestimmung der nichtlinearen antimetrischen Feder-Dämpfer-Kennfläche)

G. Patko

Technische Universität Miskolc, Lehrstuhl f. Mechanik, Ungarische VR, Maschinenbautechnik, 27 (11), pp 498-500 (Nov 1978) 1 fig, 1 table, 9 refs

(In German)

Key Words: Vibration excitation, Vibration response

Linearized substitution values of a spring element can be determined from the measurement of the first harmonic of the nonlinear vibration. If the substitution values are represented as functions of amplitude and frequency, then a general spring-damper-characteristic surface can be determined which is dependent only on position and speed.

80-1141

Chatter Vibration Prevention by Means of Low-Frequency Filtration (Vermeiden von Rattererscheinungen durch niederfrequente Filtration)

V. Goruschkin and H.G. Piegert

Maschinenbautechnik, 27 (2), pp 70-72, 76 (Feb 1978) 8 figs, 13 refs

(In German)

Key Words: Chatter, Machine tools, Vibration control

Conditions causing chatter (self-excited vibrations) of machine tools as well as the effects of low frequency filtration are described. Design techniques for reducing chatter are presented.

80-1142

Frequency Analysis of a Thick-Rim Flywheel

D.N. Fanning

Oak Ridge National Lab., TN, Rept. No. ORNL/TM-5804, 50 pp (Sept 1978)
N79-32555

Key Words: Flywheels, Natural frequencies, Finite element technique, Transfer matrix method, Computer programs

The calculation of natural frequencies of a thick rim flywheel is presented using two analysis methods: the finite element method and the transfer matrix method. A listing of the computer program developed using the transfer matrix method is included.

80-1143
On the Aerodynamic Mechanism of Torsional Flutter of Bluff Structures
Y. Nakamura
Research Inst. for Applied Mechanics, Kyushu Univ., Fukuoka, Japan, J. Sound Vib., 67 (2), pp 163-177 (Nov 22, 1979) 15 figs, 12 refs

Key Words: Wind-induced excitation, Flutter, Torsional response, Wind tunnel tests, Experimental data, Bridges, Suspension bridges, Buildings, Multistory buildings

This paper is concerned with theoretical and experimental investigations on the aerodynamic mechanism of torsional flutter of bluff structures. In the experiment, measurements were made of the unsteady aerodynamic lifts and moments acting on two rectangular bar models which were forced to oscillate either in a torsional or in a heaving mode in a uniform wind tunnel flow. The effect of the pivotal position on torsional flutter of bluff structures is also investigated.

80-1144
The Identity Between the Rayleigh-Kohn and Newton-Raphson Procedures and its Application to the Vibration Analysis of Single-Junction Branched Systems
B. Dawson and M. Davies
Div. of Engrg., Polytechnic of Central London, London W1M 8JS, UK, J. Sound Vib., 67 (2), pp 151-162 (Nov 22, 1979) 4 figs, 2 tables, 9 refs

Key Words: Branched systems, Natural frequencies, Mode shapes, Newton-Raphson method, Rayleigh-Kohn method, Iteration

This paper presents an iterative procedure for determining the natural frequencies and mode shapes of vibration of single-junction branched systems that enables large order systems of this class to be solved. The method is based on the Holzer table but with the modification that the junction rotor is considered as the residual torque rotor, and the vibration amplitude of the residual rotor is always normalized to unity. The method is illustrated by application to a typical marine system.

80-1145
Transportation of Vibration Sensitive Equipment by Highway Trailer on an Intermodal Railcar - Volume 1
M. Kenworthy
Engrg. Test and Analysis Div., ENSCO, Inc., Alexandria, VA, Rept. No. FRA/ORD-79/05.1, DOT/FR-79/04, 125 pp (July 1979)
PB-301 219/2GA

Key Words: Transportation effects, Cargo transportation, Rail transportation, Equipment response

The report includes the results of a cooperative research project between Government and industry to explore the potential for the use of highway trailers on intermodal railcars (Trailer on Flatcar) or (TOFC) to transport vibration sensitive lading. The purpose of the project was to characterize the operating environment of TOFC during the transport of vibration-sensitive teletypewriters. To this end, the lading, two types of trailers and the conventional TOFC flatcar were instrumented to quantify the shock and vibration environment during typical over-the-road revenue operation.

80-1146
Lower Bound on Forcing Amplitude for Stability of Forced Oscillations in a Third Order Non-Linear System
A.K. Mittal
Dept. of Physics, Univ. of Allahabad, Allahabad,

India, J. Sound Vib., 67 (1), pp 69-74 (Nov 8, 1979) 1 fig, 15 refs

Key Words: Non-linear systems, Forced vibration

An example of a third order non-linear system is given.

MECHANICAL PROPERTIES

DAMPING

(Also see Nos. 1021, 1036, 1064)

80-1147

Influence of Viscous-Coulomb Damping on a System with Stops

R. Dragani and A. Repaci

Inst. of Rational Mechanics, Politecnico, Torino, Italy, Mech. Res. Comm., 6 (5), pp 283-288 (May 1979) 6 figs, 12 refs

Key Words: Viscous damping, Coulomb friction, Non linear systems, Periodic response, Forced vibrations

A simple general method is developed here to analyze the effect of the viscous and Coulomb damping on the response curves in amplitude and phase for steady state forced vibrations of a non linear system with one degree of freedom with stops. The method turns the solution of the proposed motion equation into the study of a system of two simple equations, thus obtaining the response curves.

FATIGUE

(Also see Nos. 995, 1070)

80-1148

A Theoretical Study on the Fatigue Life Distribution of Metallic Materials near the Fatigue Limit

T. Tanaka and T. Sakai

Faculty of Science and Tech., Ritsumeikan Univ., Kyoto, Japan, Bull. JSME, 22 (173), pp 1517-1524 (Nov 1979) 14 figs, 21 refs

Key Words: Fatigue life

In order to theoretically derive the fatigue life distributions of metals and alloys, it is assumed that a propagative fatigue crack is initiated at the region on the specimen surface where the slips occur in two or more mutually adjoined grains. The orientation of a grain is distributed uniformly in every direction. Then, the linear models for the configuration of grains in the surface layer are combined with these assumptions for the simplicity of formulation.

80-1149

Prediction Methods for Fatigue Crack Growth in Aircraft Material

J. Schijve

Technische Hogeschool, Delft, Netherlands, Rept. No. LR-282; ICAF-1100, 44 pp (June 1979) N79-33498

Key Words: Fatigue life, Crack propagation

A survey is given of relevant knowledge on fatigue crack growth and qualitative and quantitative understanding of predictions. Aspects of cycle-by-cycle predictions and characteristic K prediction methods are discussed. Prediction problems are covered including: crack growth under flight-simulation loading with crack closure measurements; predictions for flight-simulation loading based on a constant crack opening stress level; and crack growth under pure random loading with different s sub rms-values, two irregularities, and two crest factors. Random load tests carried out to explore the usefulness of K sub rms are discussed.

80-1150

Fatigue Life Prediction of Bonded Primary Joints (Final Report, 1 Feb 1978 - 15 Mar 1979)

J.F. Knauss

Vought Corp. Advanced Technology Center, Inc., Dallas, TX, Rept. No. NASA-CR-159049; ATC-R-92100/9CRL-17, 78 pp (Sept 1979) N79-31614

Key Words: Fatigue life, Prediction techniques, Composite structures, Joints (junctions)

The specific objectives of the study are: to ascertain the feasibility of predicting fatigue failure of an adhesive in a primary bonded composite structure by incorporating linear elastic crack growth behavior; and to ascertain if acoustic emission and/or compliance measurement techniques can be used to detect flaws.

80-1151
Fatigue Failure of Composite Laminates
N.Q. Nguyen and J.L. Kardos
Materials Res. Lab., Washington Univ., St. Louis, MO, Rept. No. AFML-TR-79-4035, 36 pp (Apr 1979)
AD-A073 899/7

Key Words: Composite materials, Layered materials, Fatigue life

The purpose of this program is to provide fatigue data on a graphite-epoxy composite. AS/3501-5A was selected as the test material. Unidirectional composites with 0 and 90 degree ply orientations were tested. Both static and fatigue strength were measured. The fatigue data were analyzed using Weibull parameters.

80-1152
Generation of a Representative Load Sequence for the Fatigue Testing of Macchl MB 326H Spar Booms
L.R. Gratzer
Aeronautical Research Labs., Melbourne, Australia, Rept. No. ARL-STRUC NOTE - 450, 25 pp (Jan 1979)
AD-A074 155/3

Key Words: Antennas, Fatigue tests, Computer aided techniques

This note describes the generation of histories by use of automatic data processing techniques and linear programming. The example used is the Macchi center section spar boom which is being tested under the design load history to supplement earlier data obtained under less realistic load sequences.

ELASTICITY AND PLASTICITY

80-1153
Computerized Processing and Graphic Representation of Viscoelastic Material Property Data
C.S. King, Jr.
Univ. of Dayton Research Inst., 300 College Park, Dayton, OH 45469, Rept. No. AFML-TR-79-4099, 150 pp (Aug 1979) 2 figs, 7 refs

Key Words: Viscoelastic properties, Computer-aided techniques, Graphic methods, Computer programs

A computer program is developed to accomplish the technology advancements for the viscoelastic material properties data.

80-1154
Dynamic Response of a Slab of Elastic-Visco-plastic Material that Exhibits Induced Plastic Anisotropy
J. Aboudi and S.R. Bodner
Material Mechanics Lab., Technion - Israel Inst. of Tech., Haifa, Israel, Rept. No. MML-67, SCIENTIFIC-1, AFOSR-TR-79-0964, 41 pp (Aug 1979)
AD-A074 375/7

Key Words: Slabs, Dynamic response, Viscoplastic properties

Various two-dimensional problems of the dynamic loading of a slab are solved for a material characterization that is elastic-viscoplastic and exhibits anisotropic work-hardening. The governing constitutive equations are based on a unified formulation which requires neither a yield criterion nor loading or unloading conditions. They include multi-dimensional anisotropic effects induced by the plastic deformation history. The theory also considers plastic compressibility which The theory also considers plastic compressibility which depends on the extent of anisotropy. A numerical procedure for solving equations is developed which incorporates the history dependent anisotropic hardening effects. Cases considered are the dynamic penetration of a slab by a rigid cylindrical indenter, and a distributed force rapidly applied over part of the slab surface. Both conditions of fixed and free rear surfaces of the slab are examined. A uniaxial problem is also considered in which different bases for the anisotropic hardening law are examined.

EXPERIMENTATION

MEASUREMENT AND ANALYSIS

(Also see Nos. 1110, 1112, 1115)

80-1155
An Impulse Method of Measuring Normal Impedance at Oblique Incidence
J.C. Davies and K.A. Mulholland

Dept. of Bldg. Engineering, Univ. of Liverpool, Liverpool L69 3BX, UK, J. Sound Vib., 67 (1), pp 135-149 (Nov 8, 1979) 20 figs, 25 refs

Key Words: Acoustic absorption, Measurement techniques

An experimental method of determining the oblique incidence behavior of sound absorbing materials is given. The method involves the measurement of acoustic impulses at the surface of an absorbing material and comparing the complex frequency components with those of a reference signal recorded remote from the surface. Amplitude and phase characteristics of the reflected signal are thus obtained and hence the normal impedance of the material is found.

80-1156

Effect of the Attachment of Vibration Pickups on the Accuracy of Measurement (Einfluss der Befestigung von Schwingungsaufnehmern auf die Messgenauigkeit)

R. Gosele and W. Kotter

Institut f. Werkzeugmaschinen der Universität, Stuttgart, Germany, Konstruktion, 31 (10), pp 393-398, (Oct 1979) 13 figs, 10 refs

(In German)

Key Words: Accelerometers, Vibration measurement, Measurement techniques, Cylinders, Machinery vibrations

In this paper, the effective frequency range on rough curved surfaces as they usually appear in practice is investigated. The experimental results are summarized in two figures and two tables, from which the user may select either the proper means of attachment or suitable frequency range.

DYNAMIC TESTS

(Also see Nos. 973, 988, 1005, 1224, 1232, 1233)

80-1157

Design and Application of a Test Rig for Supercritical Power Transmission Shafts

M. Darlow and A. Smalley

Mechanical Technology, Inc., Latham, NY, Rept. No. NASA-CR-3155; MTI-78TR41, 168 pp (Aug 1979)

N79-31603

Key Words: Test stands, Test facilities, Shafts (machine elements), Power transmission systems

The design, assembly, operational check-out and application of a test facility for testing supercritical power transmission shafts under realistic conditions of size, speed and torque are described. Alternative balancing methods and alternative damping mechanisms are demonstrated and compared. The influence of torque upon the unbalance distribution is studied, and its effect on synchronous vibrations is investigated. The feasibility of operating supercritical power transmission shafting is demonstrated.

80-1158

Dynamic Stability Measurements from Tunnel Unsteadiness Excited Random Response

H.S. Murthy, R.V. Jategaonkar, and S. Balakrishna

National Aeronautical Lab., Bangalore, India, J. Aircraft, 17 (1), pp 7-12 (Jan 1980) 8 figs, 23 refs

Key Words: Dynamic stability, Wind tunnel tests, Testing techniques, Random response

A novel technique utilizing the tunnel unsteadiness as primary excitation on flexure-mounted models for dynamic stability measurements in a trisonic blowdown tunnel is presented in this paper. A time series autoregressive modeling technique is used for deriving a digital spectrum of the unsteadiness excited model response and the system damping is evaluated from the half-power bandwidth of the spectrum.

80-1159

Reference Parameters for Shock Inputs and Shock Tolerance Limits

K.E. Meier-Doernberg

Inst. f. Mechanik, Technische Hochschule, Darmstadt, West Germany, In: AGARD Models and Analogues for the Evaluation of Human Biodyn. Response, Performance and Protect., 18 pp (June 1979)

N79-31905

Key Words: Testing techniques, Shock tests, Data processing

A data reduction technique based on control techniques and system analysis but adapted and extended for the purpose of single shock events in nonlinear systems is described. The major features of the method include evaluation and definition of system relevant input quantities and of input relevant system properties as reference parameters and uniform plotting of the various deduced shock data input values, exposure limits, safety requirements, test and design parameters, standard Fourier and response spectra in terms of the defined reference parameters. As examples, severity criteria, models, and methods which are used to describe head or whole body tolerance are compared with data by means of the established reference parameters in order to discuss their mechanical meaning and suitable range of application.

80-1160

Environmental Stress Screening. I: Comparison of Screen to No Screen

A.S. Kuwata

Lockheed Missiles & Space Co., Inc., J. Environ. Sci., 23 (1), pp 9-10 (Jan/Feb 1980) 2 figs, 2 tables

Key Words: Testing techniques, Missiles

The overall screening program, as applied today in the TRIDENT I Program began in 1973 on the POSEIDON Missile Program when a major test philosophy change was initiated. This change was made after system reliability and capability compared to system goals and requirements were extensively evaluated. As a result of the evaluation, LMSC adopted the rigorous screening program that was applied to various space programs during this time frame.

80-1161

Environmental Stress Screening. II: Determining Stress Screening Levels from Preproduction Test Experience

H.J. Caruso and W. Silver II

Westinghouse Electric Corp., Baltimore, MD, J. Environ. Sci., 23 (1), pp 11-14 (Jan/Feb 1980) 2 figs, 7 refs

Key Words: Testing techniques, Missiles

This discussion is based on vibration ED/QT performed on two digital avionics systems. The ED/QT data examined, while not always conclusive, nevertheless highlight several key areas that until now have been absent from stress screening deliberations.

80-1162

Low Frequency Acoustic Methods of Nondestruct. 'e Testing

Y.B. Lange and I.B. Moskovenko

British Library Lending Div., Boston Spa, UK, Rept. No. BLL-Risley-TR-4037-(9091.9F), 29 pp (Jan 30, 1979)

N79-30563

Key Words: Nondestructive tests, Testing techniques, Acoustic techniques

The basic low frequency acoustic methods of nondestructive testing developed and used mainly in the last 20 years are reviewed with emphasis on their physical principles, their possibilities and areas of application, and the apparatus used.

80-1163

Resonance Frequencies of Ventilated Wind Tunnels

D.G. Mabey

Royal Aircraft Establishment, Bedford, UK, AIAA J., 18 (1), pp 7-10 (Jan 1980) 3 figs, 6 refs

Key Words: Wind tunnels, Resonant frequencies, Test facilities

Experiments suggest that the theory widely used to predict the transverse resonance frequencies in slotted tunnels is in error in the 0-0.5 Mach number range. An improved theory is developed which shows that the resonance frequencies of ventilated tunnels are influenced by the depth of the plenum chamber for Mach numbers up to about M=0.6.

80-1164

New Technique for Reducing Test Section Noise in Supersonic Wind Tunnels

J.B. Anders, P.C. Stainback, and I.E. Beckwith

NASA Langley Research Ctr., Hampton, VA, AIAA J., 18 (1), pp 5-6 (Jan 1980) 2 figs, 11 refs

Key Words: Test facilities, Wind tunnels, Noise reduction

A new technique for reducing test section noise in supersonic wind tunnels is described.

80-1165

Semianechoic Dyno Facility Installed

D. Bode

Diesel Gas Turbine Prog., pp 24-25 (Dec 1979) 3 figs

Key Words: Test facilities, Dynamic tests, Vibration tests, Vibration control, Noise reduction

A semianechoic engine dynamometer test facility at Anatrol Corp., Cincinnati, Ohio is described. Founded in May, 1977, the company offers a turnkey consulting engineering service in the field of structural dynamics analysis and control, with the stated goal of assisting OEM manufacturers in developing economical production solutions for their noise and vibration problems.

80-1166

Dynamic Windtunnel Simulation of Active Control Systems

P.G. Hamel and B. Krag

Inst. f. Flugmechanik, Deutsche Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt, Brunswick, W. Germany, In: AGARD Stability and Control, 10 pp (May 1979)

N79-30233

Key Words: Test facilities, Wind tunnel tests, Simulation, Active control, Vibration control

Research studies are conducted to demonstrate the application potential of dynamic simulation in a wind tunnels test facility. Elastic mode control and ride smoothing systems are scaled to model frequency and tested in a 3 m subsonic gust windtunnel. An open loop active control ride smoothing system is optimized for the Dornier-TNT light transport aircraft experimental program.

SCALING AND MODELING

(Also see No. 1131)

80-1167

Model Tests on Earthquake Simulators - Development and Implementation of Experimental Procedures

R.S. Mills

Ph.D. Thesis, Stanford Univ., 280 pp (1979)

UM 8001975

Key Words: Model testing, Earthquake response, Simulation

The necessary capabilities of a test system for dynamic model studies is discussed and illustrated by reference to the facilities at the John A. Blume Earthquake Engineering Center at Stanford University. An actual model test serves to illustrate the accuracy of replica modeling, to assist in the development of testing methodologies and to evaluate the adequacy of a dynamic test facility.

DIAGNOSTICS

(Also see Nos. 1051, 1177)

80-1168

Vibratory and Acoustical Sounding of Machine Parts

G. Sapy

British Library Lending Div., Boston Spa, UK, Rept. No. BLL-Risley-TR-4019-(9091.9F), 9 pp (Dec 7, 1978)

N79-30561

Key Words: Diagnostic techniques, Nondestructive tests, Vibratory techniques, Acoustic techniques, Machinery components

Vibratory and acoustical techniques can be used as nondestructive tests of the structural and functional integrity of machine parts during running or when stopped, without any dismantling. Examples of the application of these techniques presented include: testing the frictional properties of surfaces by vibrational detection of the start of seizing; determining internal tightness by vibro-acoustic detection of the noise from leaks; testing the solidity of mechanical parts of an assembly by vibratory detection of play; and checking the mechanical quality of parts by vibratory or acoustic detection of cracks.

80-1169

Vibration Analysis and Nondestructive Testing Using Double-Exposure Holographic Techniques

J.M. Fahey

Naval Postgraduate School, Monterey, CA, 112 pp (June 1979)

AD-A073 457/4GA

Key Words: Diagnostic techniques, Nondestructive tests, Holographic techniques, Machinery components, Shipboard machinery

Double-exposure holograms are made of aluminum 2024-T4 rectangular plates. The double-exposure technique is applied to an aluminum plate in a nonflawed and then a flawed condition. Results of these experiments, comparing the effects at various resonant frequencies, are then compared with results previously obtained in other studies to ascertain their applicability to Naval Engineering.

condition monitoring or failure detection. Simple, cheap, highly sensitive, and robust displacement monitors are described.

80-1170

Improve Turbomachinery Reliability by Taking Corrective Procedures

J.S. Sohre

Power, 124 (1), pp 67-69 (Jan 1980) 4 figs

Key Words: Diagnostic techniques, Turbomachinery, Interaction: rotor-stator

The improvement of turbomachinery reliability by taking corrective procedures is discussed.

80-1171

On-Line Diagnostics Cut Engine Maintenance

J. Reason

Power, 124 (1), pp 27-30 (Jan 1980) 5 figs

Key Words: Diagnostic techniques, Engines

Signals from multiple engine sensors are manipulated in real time by microprocessors and are used to generate information on engine conditions in a form that is helpful to the maintenance engineer.

80-1172

Displacement Controllers as Diagnostic Devices (Verlagerungswachter als Diagnosegerate)

H. Mennenga

Ingenieurhochschule f. Seefahrt, Warnemunae/Wustrow Wissenschaftsbereich Automatisierungstechnik, Maschinenbautechnik, 27 (8), pp 356-358 (Aug 1978) 7 figs, 1 ref

Key Words: Diagnostic instrumentation, Machinery components

Wear, fracture, and deformation, as well as other structural changes of machinery, show up as displacements of structural components with respect to each other. The surpassing of certain displacement limits can be used as a criterion for

80-1173

Vibroacoustic Monitoring of the Structural Components and Aggragates of Marine Engines (Zur vibroakustischen Uberwachung von Baugruppen und Aggregaten der Schiffsmaschinenanlage)

H. Strickert, H. Mennenga, and J. Frenzel

Ingenieurhochschule f. Seefahrt Warnemunde/Wustrow, Maschinenbautechnik, 27 (5), pp 205-210 (May 1978) 14 figs, 6 refs

(In German)

Key Words: Diagnostic techniques, Monitoring techniques, Marine engines, Diesel engines, Vibratory techniques, Acoustic techniques

The application of signal analysis method is required for the analysis of the condition of a diesel engine on the main power plant. The problems of the vibration of marine engines are dealt with.

80-1174

Statistical Techniques for Automating the Detection of Anomalous Performance in Rotating Machinery

K.R. Piety and T.E. Magette

Oak Ridge National Lab., TN, 24 pp (1979) (CAM-I International Spring Seminar, New Orleans, LA, Apr 9, 1979)

CONF-790435-2

Key Words: Rotors, Rotating structures, Diagnostic techniques, Statistical analysis

The level of technology utilized in automated systems that monitor industrial rotating equipment and the potential of alternative surveillance methods are assessed. An improved anomaly recognition methodology is formulated and implemented on a minicomputer system. The effectiveness of the monitoring system was evaluated in laboratory tests on a small rotor assembly, using vibrational signals from both displacement probes and accelerometers.

80-1175

Investigation of Advanced Prognostic Analysis Techniques

R.C. Grove

Northrop Research and Technology Ctr., Palos Verdes Peninsula, CA, Rept. No. NRTC-78-47R, USARTL-TR-79-10, 261 pp (June 1979) AD-A073 553/OGA

Key Words: Gear boxes, Helicopter rotors, Failure analysis, Mathematical models, Experimental data

This report presents the results of an experimental program with the following objectives: to collect and process test data from six different UH-1 helicopter 90 degree gearboxes, tested for a total of 4712 hours under controlled conditions, and to perform a theoretical investigation and data analysis to develop and optimize trend detection and prediction algorithms for application to the processed test cell data in order to establish valid predictions of gearbox failure time.

BALANCING

(Also see No. 997)

80-1176

Balancing of a Flexible Rotor (The Sixth Report, Some Experiments of Balancing Irrespective of Characteristics of Supporting Structure)

S. Kiyoshi and M. Shuzo

Central Engrg. Labs., Nissan Motor Co., Ltd., Yokosuka, Japan, Bull. JSME, 22 (172), pp 1463-1469 (Oct 1979) 7 figs, 5 refs

Key Words: Shafts (machine elements), Rotors (machine elements), Flexible rotors, Rotor-bearing systems, Balancing techniques

Unbalanced vibration and balancing of a flexible rotor/bearing system have been studied analytically for the case of elastic support with viscous damping. Based on the theoretical results obtained, some experiments are carried out and the analysis is verified experimentally.

80-1177

Balancing Method of Multi-span, Multi-bearing Rotor System (1st Report: Multiplane, Multispeed Balancing)

F. Fujisawa and K. Shiohata

Mechanical Engrg. Research Lab., Hitachi, Ltd., Bull. JSME, 22 (173), pp 1618-1625 (Nov 1979) 9 figs, 11 refs

Key Words: Rotor-bearing systems, Balancing techniques

The least-squares method, which uses influence coefficients, is applied to a multispan, multibearing rotor system (10 bearings, 5 spans), and its effect is investigated. In this paper, the above balancing method is applied in the case where unbalance is distributed in one of the rotors in a multispan rotor system.

80-1178

Rotor Blade Tipweight Assembly

R.P. Belko and R.C. Huss

Dept. of the Army, Washington, D.C., U.S. PATENT-4 150 920 (Apr 24, 1979)

Key Words: Rotor blades, Helicopter rotors, Balancing techniques

Helicopter rotor blades require tip weights for spanwise and chordwide balance to assure that all of the blades rotate in the same track. The improved rotor blade tip weight assembly of the present invention comprises an elongated spar, preferably formed of a reinforced plastic, adapted to be connected at one end thereof to a rotor hub.

ANALYSIS AND DESIGN

ANALYTICAL METHODS

(Also see Nos. 949, 958, 978, 1043, 1201)

80-1179

An Alternative Single-Step Algorithm for Dynamic Problems

O.C. Zienkiewicz, W.L. Wood, and R.L. Taylor

Dept. of Civil Engrg., Univ. College of Swansea, Swansea, UK, Intl. J. Earthquake Engr. Struc. Dynam., 8 (1), pp 31-40 (Jan/Feb 1980) 4 figs, 7 refs

Key Words: Equations of motion, Earthquake response, Dynamic structural analysis

AD-A085 328 NAVAL RESEARCH LAB WASHINGTON DC SHOCK AND VIBRATION--ETC F/G 20/11
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In this paper, a one-step form of the weighted residual method for solving equations of motion for discrete structural problems is considered. A numerical example is included to illustrate the behavior of the algorithm for a forced ground motion with both low- and high-frequency components.

80-1180

Some Approximations in Vibrations and Wave Motion of Elastic Media

M.Y. Rondeau

Ph.D. Thesis, Michigan State Univ., 98 pp (1979)

UM 8001583

Key Words: Wave propagation, Elastic waves, Approximation methods

This paper is a study of wave propagation phenomena in a linear, elastic, isotropic, homogeneous layer. The motion is described by the integral method of Kirchhoff, derived through Hamilton's principle, which serves as the starting point for the various approximations to be developed.

80-1181

Adaptive Stochastic Control of Linear Systems with Random Parameters

R.T. Ku

Ph.D. Thesis, Massachusetts Inst. of Tech., (1979)

Key Words: Stochastic processes, Random parameters, Linear systems

In this thesis the adaptive stochastic control of linear dynamic systems with purely random parameters is investigated.

80-1182

Dynamic Analysis of Spatial Mechanisms Using Dual Successive Screw Method and D'Alembert's Principle

I.J. Lee and A.H. Soni

School of Mech. & Aerospace Engrg., Oklahoma State Univ., Stillwater, OK, J. Mech. Des., Trans. ASME, 101 (4), pp 569-581 (Oct 1979) 11 figs, 9 tables, 23 refs

Key Words: Mechanisms, Dynamic structural analysis

The method based on the application of the successive dual screw displacements and d'Alembert's principle, is developed to perform kinetostatic and dynamic analysis of space mechanisms with lower kinematic pairs.

80-1183

Indirect Control of the Forces of Constraint in Dynamic Systems

H. Hemami and B.F. Wyman

Ohio State Univ., Columbus, OH 43210, J. Dyn. Syst., Meas. and Control, Trans. ASME, 101 (4), pp 355-360 (Dec 1979) 6 figs, 34 refs

Key Words: Dynamic systems, Holonomic systems, Simulation, Biomechanics

In this paper two problems are investigated; how to control a dynamic system such that holonomic constraints are maintained and further the forces of constraint are a priori specified. Two cases of the latter are considered: constant forces of constraint and forces that are functions of the state. The dynamic system is linearized about an operating point and linear feedback is exploited for the solution of both problems. A methodology for computing the feedback gains is developed and applied to a nonhuman biped model that possesses ankle torques in the frontal plane. Simulation results are carried out for the nonlinear biped model to maintain the vertical force of constraint constant under the foot. Applications to locking of joints in natural biological systems is noted.

80-1184

Analytical Investigation of the Quadratic Frequency Response for Lateral Drifting Force and Moment

C.H. Kim and J.F. Dalzell

Davidson Lab., Stevens Inst. of Tech., Hoboken, NJ, Rept. No. SIT-DL-79-9-2061, 81 pp (May 1979)

AD-A074 162/9

Key Words: Frequency response method

Results of calculations are given for lateral drifting forces acting on a cylinder and a Series 60 hull derived by a new procedure involving application of the quadratic frequency response function (QFRF) and the close-fit method for flows induced by hull sections in the near field. The computed results are presented in a three-dimensional view accompanied by a detailed discussion of the characteristic behavior.

80-1185

Substructuring and Component Modes

W.C. Clark

Ph.D. Thesis, Oklahoma State Univ., 72 pp (1979)
UM 7928195

Key Words: Dynamic structural analysis, Substructuring methods, Component mode synthesis

The purpose of this study is to develop an accurate and economical technique for static and dynamic analysis of large complex structural systems. The proposed technique divides the structure into convenient substructures and defines generalized coordinates corresponding to component mode shapes. Component modes are obtained from deflections resulting from static loads. Two types are used: attachment modes and fixed interface modes. The attachment modes incorporate the displacements of the entire structure while the fixed interface modes refer to individual substructures.

80-1186

Response of Slightly Damped Gyroscopic Systems

L. Meirovitch and G. Ryland, II
Dept. of Engrg. Science and Mechanics, Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061,
J. Sound Vib., 67 (1), pp 1-19 (Nov 8, 1979) 4 figs, 3 tables, 6 refs

Key Words: Gyroscopes, Damped structures, Perturbation theory, Eigenvalue problems

A second-order perturbation theory is developed for the response of slightly damped gyroscopic systems. The solution is based on the eigensolution for undamped gyroscopic systems and is expressed in terms of real quantities alone.

80-1187

A Special Case of Integrability in a System with One Quasi-Cyclic Coordinate

P. Hagedorn
Institut f. Mechanik, Technische Hochschule Darmstadt, D6100 Darmstadt, Germany, Intl. J. Nonlin. Mech., 14 (3), pp 143-147 (1979) 1 fig, 10 refs

Key Words: Equations of motion

It is well known that conservative holonomic and scleronomic systems with two degrees of freedom which have one cyclic coordinate are 'integrable'. This means that the solution to the equations of motion can be given analytically in terms of quadratures, due to the existence of the two first integrals: the energy integral and the integral corresponding to the cyclic coordinate.

80-1188

Optimal Control of a Non-Linear Noisy Sine Wave Oscillator

Y. Yavin, M. Friedman, and E. Solomon
Dept. of Electrical Engrg., Ben-Gurion Univ., Beer-Sheva, Israel, Intl. J. Nonlin. Mech., 14 (3), pp 205-219 (1979) 15 figs, 11 refs

Key Words: Oscillators, Non-linear theories, Random excitation

This paper deals with the optimal control of a random nonlinear sine wave oscillator. It is assumed that the oscillator is subjected to two different kinds of perturbation. The first kind of perturbation is represented by a vector of independent standard Wiener processes and the second kind by a generalized type of a Poisson process. Sufficient conditions on the optimal controls are derived. These conditions are given by a set of two coupled non-linear partial integro-differential equations. A numerical procedure for the solution of these equations is suggested and its efficiency and applicability are demonstrated with examples.

80-1189

An Assessment of the Poincare Scheme for Non-Linear Oscillators and an Improvement of its Range of Validity

H. Engin, A. Askar, and A.S. Cakmak
Princeton Univ., Dept. of Civil Engrg., Princeton, NJ 08540, Intl. J. Nonlin. Mech., 14 (5/6), pp 305-314 (1979) 3 figs, 1 table, 8 refs

Key Words: Oscillators, Nonlinear theories

The range of validity of the Poincare method is studied by comparison with the exact solution for the anharmonic and Morse oscillators. The exact solutions for these cases are expressible respectively in terms of elliptic and inverse trigonometric functions. The oscillation frequency is taken as the basis for the comparison. A new method is presented as a slight variation over the standard Poincare method. This method differs from the former only by a rearrangement of the differential equation through a collocation approximation for the potential.

MODELING TECHNIQUES

(Also see Nos. 955, 957, 958, 985, 994
1011, 1023, 1027, 1079, 1080, 1206)

80-1190
Modeling of Room Response to Air Blasts
D. Keefer
Tennessee Univ. Space Inst., Tullahoma, TN, Rept. No. ARO-16395.1-A-E, 26 pp (Aug 22, 1979)
AD-A073 555/5GA

Key Words: Mathematical models, Air blast, Blast response, Rooms

A relatively simple model is developed for the prediction of pressure response within a one room structure subjected to air blast. The model is based on an acoustic analysis and a room fill model. These models are combined, together with a model for the entering diffracted shock, to produce a model which can predict the pressure-time response at any spatial location within the room. Good agreement is obtained when the model predictions are compared with measurements obtained from full scale field tests and scaled shock tube tests.

80-1191
Simplified Design Methods for Nonlinear Dynamic Mechanical Systems
T.M. Frick
Advanced Reactors Div., Westinghouse Electric Corp., Pittsburgh, PA, Rept. No. CONF-790608-1, 33 pp (1979)
N79-31610

Key Words: Mathematical models, Nonlinear systems, Earthquake response, Simulation, Seismic design

Dimensional analysis and classical methods are combined in a novel way to develop a simplified mathematical description of two practical nonlinear mechanical systems experiencing excitation similar to that due to an earthquake. This method is used to obtain system descriptions in closed algebraic form with appropriate constants. Predictions based on application of the method are made. Application of the method to other systems is briefly discussed.

80-1192
Automatic Formulation and Solution Techniques in Dynamics of Machinery
A.U. Amin
Ph.D. Thesis, Univ of Pennsylvania, 187 pp (1979)
UM 7928104

Key Words: Machinery, Mathematical models, Computer programs, Dynamic structural analysis

Dynamic analysis problems in planar machines are formulated in a systematic manner in order to develop general purpose computer programs. Generalized modeling techniques are developed to accommodate arbitrary constraints due to higher pairs and motion generators.

80-1193
Problems of Machine Modeling with Beam Elements (Probleme der Modellierung von Maschinen mit Balkenelementen)
H. Aurich
Technische Hochschule Karl-Marx-Stadt Sektion Verarbeitungstechnik, Maschinenbautechnik, 27 (5), pp 211-212 (May 1978) 3 figs, 1 table, 6 refs
(In German)

Key Words: Machinery components, Finite element technique, Mathematical models, Beams

The finite element method makes use of several types of elements, therefore the use of beam elements for the modeling of complicated machine parts results in problems. Proposals for the solution of the problems are discussed.

80-1194
A Finite Element Method for Random Differential Equations with Random Coefficients
T. Sun
Dept. of Mathematics, Wayne State Univ., Detroit, MI 48202, SIAM J. Numer. Anal., 16 (6), pp 1019-1035 (Dec 1979) 7 refs

Key Words: Finite element technique, Random parameters

A finite element method is derived for solving random differential equations with random coefficients.

80-1195
Analysis of Static and Dynamic Structural Problems by a Combined Finite Element-Transfer Matrix
G. Chiatti and A. Sestieri

Istituto di Macchine e Tecnologie Meccaniche, Universita di Roma, Rome, Italy, J. Sound Vib., 67 (1), pp 35-42 (Nov 8, 1979) 1 fig, 2 tables, 11 refs

Key Words: Dynamic structural analysis, Finite element technique, Transfer matrix methods

In this paper some interesting applications are emphasized for both static and dynamic problems of structures. A great deal of attention is paid to the use of shell isoparametric elements for very thin structures, where the usual numerical integration by a two-by-two Gaussian quadrature of the stiffness matrix leads to an ineffective increase of stiffness in the structure. Particularly appealing seems to be the use of quadratic shell elements in the FETM method.

NONLINEAR ANALYSIS

(Also see No. 1207)

NUMERICAL METHODS

(Also see Nos. 1025, 1067, 1123, 1144)

80-1196

Moments of Time to First Passage of the Linear Oscillator

L.A. Bergman

Ph.D. Thesis, Case Western Reserve Univ., 204 pp (1979)
UM 8001449

Key Words: Oscillators, Numerical analysis

The first four moments of time to first passage of the linear, single degree-of-freedom oscillator subjected to stationary white noise excitation are obtained by means of a numerical solution of its Pontriagin-Vitt equation. A system of approximating difference equations is developed using a Petrov-Galerkin finite element method with upstream weights. The system is solved recursively for the required number of statistical moments.

80-1197

Spectral Problems in Vibration Mechanics

J. Boujot

European Space Agency, Paris, France, Rept. No. ESA-TT-497; ONERA-P-1978-2, 67 pp (Feb 1979)
N79-30580

Key Words: Spectrum analysis, Numerical analysis

Vibration problems in linear theory are related to fundamental theory in functional and spectral analysis. Some results on spectral decomposition and spectral variational properties are recalled. A general theorem for linear oscillation is proven and some applications studied. An introduction to numerical analysis and computational techniques is given with application to system vibration modes.

80-1198

A Direct Integration Method for Analysis of a Certain Class of Nonlinear Dynamic Problems

M. Gellert

Dept. of Civil Engrg., Technion-Israel Inst. of Tech., Technion City, Haifa 32000 Israel, Ing. Arch., 48 (6), pp 403-415 (1979) 14 figs, 30 refs

Key Words: Nonlinear theories, Numerical analysis, Dynamic systems, Algorithms

A new efficient algorithm for direct integration of a class of non-linear dynamic systems is presented.

80-1199

New Developments in the Inelastic Analysis of Quasi-static and Dynamic Problems

J.H. Argyris, J. St. Doltsinis, and K.J. William

Institut f. Statik and Dynamik der Luft- und Raumfahrtkonstruktionen, Univ. of Stuttgart, W. Germany, Intl. J. Numer. Methods Engr., 14 (12), pp 1813-1850 (1979) 28 figs, 25 refs

Key Words: Numerical analysis, Dynamic structural analysis

The computational aspects are examined for the numerical analysis of inelastic structures and continua. The tracing of quasistatic and dynamic motions is considered with particular emphasis on the interaction of nonlinear and transient problems. In the first part, explicit and implicit solution schemes are developed for the numerical integration of inelastic first-order rate processes governing creep, viscoelasticity and viscoplasticity. In the second part, the exposition is extended to second-order inertial problems and in particular to the field of dynamic plasticity, devoting special attention to the kinematics of finite deformation problems.

STATISTICAL METHODS

(Also see Nos. 959, 984)

80-1200

A Unified Statistical Treatment for the Multi-Variate Joint Probability Expression of General Random Processes in the Form of Finite Expansion Terms

M. Ohta, Y. Yamaguchi, and S. Hiromitsu
Dept. of Electrical Engrg., Hiroshima Univ., Hiroshima, Japan, J. Sound Vib., 67 (4), pp 439-457 (Dec 22, 1979) 4 figs, 2 tables, 9 refs

Key Words: Random response, Statistical analysis, Probability theory

In this paper, for a multi-variate random process of arbitrary distribution type which can be considered to be a sum of two different random processes as a result of the natural internal mechanism of the fluctuation, or of an artificial analytical classification of the fluctuation, a unified statistical treatment for the multi-variate joint probability distribution and the multi-variate joint moment with arbitrary order of the resultant random process is introduced exactly in the form of finite expansion terms.

PARAMETER IDENTIFICATION

(Also see Nos. 972, 993, 994)

80-1201

Computational Methods of System Identification and Parameter Estimation

W. Cheng

Ph.D. Thesis, The Univ. of Texas at Arlington, 186 pp (1979)
UM 8001658

Key Words: System identification technique, Parameter identification technique, General method of moments, Direct computational method

System identification, by way of impulse response identification and parameter estimation using observed input-output data, is considered. First, a general moment theory, called the general method of moments (GMOM), is developed by using linear operator theory. Second, a new method, called the direct computational method (DCM), is derived from GMOM. Computational procedure is given. Numerical examples are also presented using both computer-simulated data and experimental data to illustrate the performance of DCM as well as GMOM. Comparison of some identification methods is provided. In addition, application to fluorescence decay analysis and, as a case study, modeling and identification of an inner gimbal assembly telescope on an airborne pointing and tracking system are discussed in detail.

80-1202

A System Identification Methodology Using Dynamic Data for Analysis of Mechanisms

S. M. Wu
Dept. of Mech. Engrg., Wisconsin Univ., Madison, WI,
Rept. No. ARO-14726.3-A-M, 59 pp (Aug 1979)
AD-A074 023/3

Key Words: System identification technique, Weapons systems, Dynamic response

Signals representing the force and displacement of the table of the M-139 machine gun during firing are analyzed. Force data during and after firing were represented by the 4th and 6th order stochastic differential equation models.

80-1203

Lateral Aerodynamics Extracted from Flight Test Using a Parameter Estimation Method

R.A. Feik
Aeronautical Research Labs., Melbourne, Australia,
Rept. No. ARL-AERO-NOTE-380; AR-001-311, 45 pp (Oct 1978)
N79-31146

Key Words: Parameter identification technique, Flight tests, Aerodynamic characteristics

Flight data from a 60 deg delta wing aircraft is analyzed using a modified Newton-Raphson parameter estimation procedure. The model equations used for the analysis are extended to account for sideslip vane errors and for lateral accelerometer position error. Lateral derivatives extracted from the data are compared with wind tunnel measurements and theoretical estimates and areas of agreement and disagreement identified. The method is also applied to the analysis of fin loads measured in flight and some tentative conclusions reached.

OPTIMIZATION TECHNIQUES

(See No. 1229)

DESIGN TECHNIQUES

(Also see Nos. 976, 1235, 1236)

80-1204

Optimum Design of Laminates with Natural Frequency Constraints

S.S. Rao and K. Singh

Dept. of Mech. Engrg., Indian Inst. of Tech., Kanpur 208016, India, J. Sound Vib., 67 (1), pp 101-112 (Nov 8, 1979) 2 figs, 3 tables, 13 refs

Key Words: Layered materials, Fiber composites, Design techniques, Optimum design, Natural frequencies

A method of optimally designing symmetric fiber reinforced composite laminates subject to constraints on natural frequencies is presented. The problem is cast as a non-linear mathematical programming problem in which the thicknesses of material placed at preassigned orientation angles are treated as the design variables. The resulting optimization problem is solved by using an interior penalty function algorithm. Several non-linear programming problems are solved by taking minimization of weight or maximization of fundamental frequency/buckling load/maximum transverse deflection under the stated loading condition as the behavior constraints. The numerical results are presented in the form of design studies.

COMPUTER PROGRAMS

(Also see Nos. 1022, 1041, 1053, 1080, 1092, 1109, 1142, 1153, 1192)

80-1205

An Evaluation of the ADINA Finite Element Program for Application to Aircraft Overpressure Vulnerability

T.R. Stagliano and L.J. Mente

Kaman Avidyne, Burlington, MA, Rept. No. KA-TR-162, DNA-4876F, AD-E300 579, 81 pp (Feb 1979)
AD-A074 261/9

Key Words: Computer programs, Finite element technique, Aircraft, Vulnerability

In aircraft overpressure vulnerability, stiffened thin-walled panel configurations are subjected to surface pressure loadings of varying time histories. These dynamic loads subject the impinged structural components to large deflections and an elastic-plastic material response. The ADINA (Automatic Dynamic Incremental Nonlinear Analysis) computer code is evaluated to determine if it is a numerically accurate, computationally efficient means of analyzing these complex structures under transient pressure loading.

80-1206

Improved Numerical Procedures for Soil-Structure Interaction Including Simulation of Construction Sequences

J.G. Lightner, III and C.S. Desai

Dept. of Civil Engrg., Virginia Polytechnic Inst. and State Univ., Blacksburg, VA, Rept. No. VPI-E-79-32, 150 pp (Sept 1979)
PB-300 620/2GA

Key Words: Interaction: soil-structure, Mathematical models, Computer programs

A formulation for modeling soil-structure interaction is presented. In conjunction with the formulation, a computer code is written to implement it. Several problems are analyzed to demonstrate the validity of the code. The program called SEQCON utilizes an eight-node isoparametric quadrilateral. An interface and bar are also available. Four material models are used. They are the linear elastic, hyperbolic, Drucker-Prager, and cap model. Several construction sequence steps are modeled. They include in situ, dewatering, excavation, deposition (embankment) and tiebacks.

80-1207

Explicit Time Integration Operators for Nonlinear Structural Dynamics

W.C. Knudson and G.V. Suryakumar

Inst. f. Statik und Dynamik der Luft- und Raumfahrtkonstruktionen, Stuttgart Univ., W. Germany, Rept. No. ISD-250, 107 pp (Sept 1978)
N79-30581

Key Words: Nonlinear theories, Dynamic structural analysis, Computer programs

Explicit temporal algorithms, advantageous for nonlinear structural dynamics problems, are considered. The stability and accuracy characteristics of the Newmark (beta=0) and the central difference methods are widely studied and well

established. Two recent explicit methods, Fu's method and Trujillo's method (alternating direction explicit) are also examined for their stability and accuracy characteristics. Finally, the accuracy and computer time requirements of Newmark's (beta=0) algorithm and the higher order cubic Hermitian algorithm, both implemented within the LARSTRAN computer package, are compared. Additional comparisons with the alternating direction explicit method are also provided.

80-1208

ATLAS, An Integrated Structural Analysis and Design System. Volume 3: User's Manual, Input and Execution Data

Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-159043; D6-25400-0003-Vol-3, 698 pp (July 1979)

N79-31622

Key Words: Computer programs, Dynamic structural analysis

The input data and execution control statements for the ATLAS integrated structural analysis and design system are described. ATLAS is a modular system of computer codes with common executive and data base management components. The system provides an extensive set of general-purpose technical programs with analytical capabilities including stiffness, stress, loads, mass, substructuring, strength design, unsteady aerodynamics, vibration, and flutter analyses.

80-1209

The Dynamic Analysis of Structures: A Comparison Between Two Different Versions of Strudl 2

B. Atzori and F. Fresa

1st di Costruzioni di Macchine, Bari Univ., Italy, 24 pp (1978)

N79-32599

Key Words: STRUDL (Computer programs), Computer programs, Dynamic structural analysis

The various possibilities for performing a dynamic structural analysis, available in two different versions of STRUDL 2, are evaluated in relation to very simple structures for which the analytical solutions are known. The study is performed using mainly beam elements. The values of the C.P.U. time required to perform the various analyses are also given as a function of the number of degrees of freedom of the analyzed structure.

80-1210

Time History Solution Program, L225 (TEV126). Volume 1: Engineering and Usage

R.I. Kroll, A. Tornallyay, and R.E. Clemmons

Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-2859; D6-44468-Vol-1, 105 pp (Sept 1979)

N79-32161

Key Words: Computer programs, Time domain method

Volume 1 of a two volume document is presented. The usage of the convolution program L225 (TEV 126) is described. The program calculates the time response of a linear system by convoluting the impulsive response function with the time-dependent excitation function. The convolution is performed as a multiplication in the frequency domain. Fast Fourier transform techniques are used to transform the product back into the time domain to obtain response time histories. A brief description of the analysis used is presented.

80-1211

Random Harmonic Analysis Program, L221 (TEV-156). Volume 2: Supplemental System Design and Maintenance Document

M.L. Graham, R.E. Clemmons, and R.D. Miller

Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-2858; D6-44467-Vol-2, 113 pp (Sept 1979)

N79-32162

Key Words: Computer programs, Frequency domain method

Volume 2 of a two volume document is presented. A computer program, L221 (TEV 156), available for execution on the CDC 6600 computer is described. The program is capable of calculating steady-state solutions for linear second-order differential equations due to sinusoidal forcing functions. From this, steady-state solutions, generalized coordinates, and load frequency responses may be determined. Statistical characteristics of loads for the forcing function spectral shape may also be calculated using random harmonic analysis techniques. The particular field of application of the program is the analysis of airplane response and loads due to continuous random air turbulence.

80-1212

Dynamic Loads Analysis System (DYLOFLEX) Summary. Volume 1: Engineering Formulation

R.D. Miller, R.I. Kroll, and R.E. Clemmons

Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-2846-1; D6-44455-Vol-1, 88 pp (Sept 1979)
N79-31144

Key Words: Computer programs, Dynamic loads

The DYLOFLEX computer program system expands the aeroelastic cycle from that in the FLEXSTAB computer program system to include dynamic loads analyses involving active controls. Two aerodynamic options exist within DYLOFLEX. The analyst can formulate the problem with unsteady aerodynamics calculated using the doublet lattice method or with quasi-steady aerodynamics formulated from either FLEXSTAB or doublet lattice steady state aerodynamics with unsteady effects approximately by indicial lift growth functions. The equations of motion are formulated assuming straight and level flight and small motions. Loads are calculated using the force summation technique. DYLOFLEX consists of nine standalone programs which can be linked with each other by magnetic files used to transmit the required data between programs.

80-1213

Dynamic Loads Analysis System (DYLOFLEX) Summary. Volume 2: Supplemental System Design Information

R.D. Miller, R.I. Kroll, and R.E. Clemmons
Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-2846-2; D6-44455-Vol-2, 60 pp (Sept 1979)
N79-31145

Key Words: Computer programs, Dynamic loads

The contents of this article include the execution of the DYLOFLEX program system; magnetic file format; DYLIB - the DYLOFLEX alternate subroutine library; and prefaces for DYLIB subroutines.

80-1214

Time History Solution Program, L225 (TEV126). Volume 2: Supplemental System Design and Maintenance Document (Topical Report, May 1975 - May 1977)

A. Tornallyay, R.E. Clemmons, and R.I. Kroll
Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-2860; D6-44469-Vol-2, 34 pp (Sept 1979)
N79-31154

Key Words: Computer programs, Time domain method, Frequency domain method, Fast Fourier transformation

The time history solution program L225 (TEV126) is described. The program calculates the time responses of a linear system by convoluting the impulsive response functions with the time dependent excitation. The convolution is performed as a multiplication in the frequency domain. Fast Fourier transform techniques are used to transform the product back into the time domain to obtain response time histories. The design and structure of the program is presented.

80-1215

Equation Modifying Program, L219 (EQMOD). Volume 2: Supplemental System Design and Maintenance Document (Topical Report, May 1975 - May 1977

M.Y. Hirayama, R.E. Clemmons, and R.D. Miller
Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-2856; D6-44465-Vol-2, 65 pp (Sept 1979)
N79-31153

Key Words: Computer programs, Equations of motion

A digital computer program, L219 (EQMOD), available for execution on the CDC 6600 is described. The program modifies matrices according to card input instructions and prepares magnetic files of matrices suitable for use in the linear systems analysis program (QR) and the random harmonic analysis program L221 (TEV156). The particular field of application of the program is the modification of the theoretical equations of motion and load equations generated in DYLOFLEX by the equation of motion program (L217) and the load equation program (L218), respectively.

80-1216

A Program to Compute Three-Dimensional Subsonic Unsteady Aerodynamic Characteristics Using the Doublet Lattice Method, L216 (DUBFLEX). Volume 2: Supplemental System Design and Maintenance Document (Topical Report, May 1975 - May 1977)

B.A. Harrison and M.R. Washington
Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-2850; D6-44459, 75 pp (Sept 1979)
N79-31148

Key Words: Computer programs, Aerodynamic characteristics

The information necessary for execution of the digital computer program L216 on the CDC 6600 is described. L216 characteristics are based on the doublet lattice method. Arbitrary aerodynamic configurations may be represented with combinations of nonplanar lifting surfaces composed of finite constant pressure panel elements, and axially symmetric slender bodies composed of constant pressure line elements. Program input consists of configuration geometry, aerodynamic parameters, and modal data; output includes element geometry, pressure difference distributions, integrated aerodynamic coefficients, stability derivatives, generalized aerodynamic forces, and aerodynamic influence coefficient matrices. Optionally, modal data may be input on magnetic field (tape or disk), and certain geometric and aerodynamic output may be saved for subsequent use.

80-1217

A Program for Calculating Load Coefficient Matrices Utilizing the Force Summation Method, L218 (Loads). Volume 2: Supplemental System Design and Maintenance Document (Topical Report, May 1975 - May 1977)

L.R. Anderson and R.D. Miller

Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-2854; D6-44463-Vol-2, 94 pp (Sept 1979)

N79-31155

Key Words: Computer programs, Flight vehicles, Dynamic structural analysis

The LOADS computer program L218 which calculates dynamic load coefficient matrices utilizing the force summation method is described. The load equations are derived for a flight vehicle in straight and level flight and excited by gusts and/or control motions. In addition, sensor equations are calculated for use with an active control system. The load coefficient matrices are calculated for the following types of loads: translational and rotational accelerations, velocities, and displacements; panel aerodynamic forces; net panel forces; and shears, bending moments, and torsions.

80-1218

RAYSTC: A Computer Code for Calculating Single Ray-Path Statistics, Assuming the Garrett-Munk Model of Internal Waves

M.L. Blodgett

Naval Research Lab., Washington, D.C., Rept. No. NRL-8304, AD-E000 317, 32 pp (July 25, 1979)

AD-A073 762/7GA

Key Words: Underwater sound, Computer programs

This report describes a computer program designed to calculate root-mean-square values for the acoustic phase, phase rate, and log-intensity fluctuation for a single ray path in an ocean in which the sound-speed fluctuations are the result of internal-wave activity. It is assumed that the internal waves can be described by the Garrett-Munk internal-wave model and that the theory of sound propagation developed by Munk and Zachariasen is valid.

80-1219

The Blast Noise Prediction Program: User Reference Manual

V. Pawlowska and L. Little

Construction Engrg. Research Lab. (Army), Champaign, IL, Rept. No. CERL-IR-N-75, 78 pp (Aug 1979)

AD-A074 050/6

Key Words: Computer programs, Noise prediction, Blast loads

This report provides user instructions for the U.S. Army Construction Engineering Research Laboratory's (CERL's) Blast Noise Prediction computer program, BNOISE 1.0, which is designed to predict the noise impacts of Army blast-noise operations. It is designed to serve as a reference manual and describes the manipulation of the modules used by the Blast Noise program, provides a sample run, and gives a list of module error messages.

80-1220

A Computer Program to Generate Equations of Motion Matrices, L217 (EOM). Volume 1: Engineering and Usage

R.I. Kroll and R.E. Clemmons

Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-2851; D6-44460, 161 pp (Oct 1979)

N79-33165

Key Words: Equations of motion, Computer programs, Aircraft, Aerodynamic characteristics

The equations of motion program L217 formulates the matrix coefficients for a set of second order linear differential equations that describe the motion of an airplane relative to its level equilibrium flight condition. Aerodynamic data from FLEXSTAB or Doublet Lattice (L216) programs can be used to derive the equations for quasi-steady or full unsteady aerodynamics. The data manipulation and the matrix coefficient formulation are described.

80-1221

A Computer Program to Generate Equations of Motion Matrices, L217(EOM). Volume 2: Supplemental System Design and Maintenance Document

R.E. Clemmons and R.I. Kroll

Boeing Commercial Airplane Co., Seattle, WA, Rept. No. NASA-CR-2852; D6-44461-Vol-2, 180 pp (Oct 1979)

N79-33166

Key Words: Equations of motion, Computer programs, Aircraft, Aerodynamic characteristics

The equations of motion program L217 (EOM) is described. The program formulates the matrix coefficients for a second order linear differential equation which describes the motion of an airplane relative to its level equilibrium flight condition. Aerodynamic data from FLEXSTAB or Doublet Lattice (L216) programs are used to derive the equations for quasi-steady or complete unsteady aerodynamics.

GENERAL TOPICS

CONFERENCE PROCEEDINGS

80-1222

Proceedings of the Nuclear Blast and Shock Simulation Symposium, 28-30 November 1978, Volume I

General Electric Co., Santa Barbara, CA, Rept. No. DNA-4797P-1, AD-E300 569, 455 pp (Dec 1978)

AD-A073 765/OGA

Key Words: Nuclear explosion effects, Blast effects, Simulation, Proceedings

This report contains the papers presented at the Proceedings of the Nuclear Blast and Shock Simulation Symposium held November 28-30, 1978 at the Naval Ocean Systems Center, San Diego, California, under the sponsorship of the Shock Physics Strategic Structures Division (SPSS) of the Defense Nuclear Agency. The Symposium provided a forum for the exchange of information on technical approaches and recent accomplishments in the development of nuclear blast and shock simulators. Volume I contains papers on the following topics: Site Selection and Environmental Considerations; Airblast/Thermal Effects Simulation; and Underwater Shock Simulation.

80-1223

Proceedings of the Nuclear Blast and Shock Simulation Symposium, 28-30 Nvember 1978, Volume II

General Electric Co., Santa Barbara, CA, Rept. No. DNA-4797P-2, AD-E300 570, 350 pp (Dec 1978)

AD-A073 766/8GA

Key Words: Nuclear explosion effects, Blast effects, Simulation, Proceedings

This report contains the papers presented at the Proceedings of the Nuclear Blast and Shock Simulation Symposium held November 28-30, 1978 at the Naval Ocean Systems Center, San Diego, California, under the sponsorship of the Shock Physics Strategic Structures Division (SPSS) of the Defense Nuclear Agency. The symposium provided a forum for the exchange of information on technical approaches and recent accomplishments in the development of nuclear blast and shock simulators. Volume II contains papers from sessions on the following topics: Underground Shock Simulation; Instrumentation; and High-Energy Simulation.

80-1224

Structural Aspects of Active Controls

R. Destuynder

Office National d'Etudes et de Recherches Aerospatiales, Paris, France, In: AGARD Stability and Control, 12 pp (May 1979)

N79-30221

(In French)

Key Words: Vibration control, Active control, Wind tunnel tests, Proceedings

Various papers presented at the specialists meeting sponored by the Structures and Materials Panel in Lisbon (1977) are summarized. Emphasis is placed on the following main points: (1) the use of preliminary simple calculations to cover the different configurations and the possible control laws;

(2) improvement with the help of corrections obtained by wind tunnel tests; and (3) proof, through flight test or wind tunnel test, of the validity of the solution. Progress in flutter suppression obtained at ONERA is also reported.

TUTORIALS AND REVIEWS

80-1225

An International Survey of Shock and Vibration Technology

H.E. Pusey, R.H. Volin, and J.G. Showalter

Naval Research Lab., Shock and Vibration Information Ctr., Washington, D.C., 566 pp (Mar 1979) (Availability: Naval Res. Lab., Shock and Vibration Information Ctr., Washington, D.C.)

AD-A073 621/5GA

Key Words: Reviews, Vibration response, Shock response

This report is a very broad survey of a technology from an international viewpoint. There was no attempt to cover any subject within the technology in great depth. This would be impractical in a report of this scope, since each subject area in the shock and vibration field could well be the topic for a treatise all its own. The many references cited were for the purpose of indicating trends, and, perhaps, to offer some direction to those interested in specific areas covered in this report.

80-1226

Vehicle-Guideway Interaction Problems

J. Genin and E.C. Ting

Purdue Univ., West Lafayette, IN 47907, Shock Vib. Dig., 11 (12), pp 3-9 (Dec 1979) 1 fig, 50 refs

Key Words: Reviews, Interaction: vehicle-guideway

This article discusses three general methods for studying vehicle-guideway interaction problems: moving force approximation, massless guideway approximation, and moving mass approximation. The trolley problem at the Sandia Laboratories is also summarized.

80-1227

Flow-Induced Vibration of Nuclear Reactor Fuel. Part II: Design Considerations

M.W. Wambsganss and T.M. Mulcahy

Argonne National Lab., Argonne, IL 60439, Shock Vib. Dig., 11 (12), pp 11-13 (Dec 1979)

Key Words: Reviews, Nuclear reactors, Flow-induced vibrations, Design techniques

This two-part article focuses on the role of reactor fuel in flow-induced vibrations in nuclear reactors. Part I is on mathematical modeling of the fuel assemblies. Part II describes design considerations.

80-1228

Modal Analysis for Managers

W.G. Flannelly and G.F. Lang

Kaman Aerospace Corp., Bloomfield, CT, S/V, Sound Vib., 13 (11), pp 18-23 (Nov 1979) 12 figs

Key Words: Modal analysis, Reviews

This article undertakes a discussion of modal analysis. Concepts are discussed from a physical standpoint with the use of analogies. Because modal analysis is a mathematical process, some amount of mathematical discussion is unavoidable.

80-1229

A Survey of Structural Optimization Under Dynamic Constraints

M.A.V. Rangacharyulu and G.T.S. Done

Birla Inst. of Tech. & Science, Pilani (Rajasthan), India, Shock Vib. Dig., 11 (12), pp 15-25 (Dec 1979) 98 refs

Key Words: Reviews, Optimization, Free vibration, Forced vibration

This article reviews the literature since 1970 on structural optimization under dynamic constraints. Methods used with continuous and discrete models are described for free vibration problems. Methods for forced vibration problems and nonconservative problems are also discussed.

CRITERIA, STANDARDS, AND SPECIFICATIONS

(Also see Nos. 1012, 1014)

80-1230

Noise Emission Standards for Surface Transportation Equipment - Regulatory Analysis of the Noise Emission Regulations for Truck-Mounted Solid Waste Compactors

Office of Noise Abatement and Control, Environmental Protection Agency, Arlington, VA, Rept. No. EPA/550/9-79/257, 501 pp (Aug 1979)
PB80-101488

Key Words: Regulations, Noise generation, Compaction equipment

This document presents the technical data and analysis used by EPA in developing the Noise Emission Regulations for Truck-Mounted Solid Waste Compactors. The information presented includes a detailed description of the truck-mounted solid waste compactor industry and the product; baseline noise levels for current compactors; a description of the measurement methodology; an analysis of the health and welfare impacts and potential benefits of regulation; the noise control technology available; an analysis of the costs and potential economic effects of regulation; the enforcement procedures; existing local, state, ar.' fo-ign regulations applicable to compactor noise emissio. ..alysis of comments to the public docket; and a description of the participation of the public throughout the development of the regulation.

80-1231

General Discussions for the Production of Vibration Isolators (Interpretation of TGL 35213) (Allgemeine Festlegungen fur die Produktion von Schwingungsisolatoren) (Erlauterungen zu TGL 35 213)

G. Meltzer

Zentralinstitut f. Arbeitsschutz, Leitstelle f. Lärm- und Schwingungsabwehr, Dresden, Maschinenbautechnik, 27 (4), pp 170-174 (Apr 1978) 4 figs, 17 refs
(In German)

Key Words: Isolators, Vibration isolators, Standards and codes

The aim of this vibration isolation production standard, which is still in preparation, is to present to the user with the most important service properties of vibration isolators and their maintenance. Compromises between user requirements and the obligations of manufacturer are discussed.

80-1232

A Decision Path Approach to Environmental Test Planning

S. Cohen and J. Hamilton

J. Environ. Sci., 23 (1), pp 19-32 (Jan/Feb 1980) 5 figs

Key Words: Standards and codes, Testing techniques

Research and analysis have led to the development of an approach to formulating environmental test plans based on a logic, or decision, path. This step-by-step methodology is structured to ensure that test planners and specification writers consider all aspects of their equipment and its prospective use in the operational environment before deciding how to test its suitability to withstand environmental conditions expected to be encountered in the field. This article will explain briefly how this methodology was developed and how it could be used with the forthcoming revision to MIL-STD-810C.

80-1233

Rationale for ASTM's Simple Test for Sound Isolation in Buildings

T.J. Schultz

Bolt Beranek and Newman, Inc., 50 Moulton St., Cambridge, MA 02138, Noise Control Engr., 13 (3), pp 105-111 (Nov/Dec 1979) 8 figs, 10 refs

Key Words: Standards, Testing techniques, Buildings, Acoustic insulation

Previous research has demonstrated good correlation between the results of a simple sound isolation test and tenants' subjective evaluation of their privacy. The requirements for the standard sound source which is specified in the recent American Society for Testing and Materials standard procedure E597-77T for conducting that isolation test is investigated.

80-1234

Regulations of New Products Noise Emission

D.R. Flynn

National Bureau of Standards, Washington, D.C., 8 pp (Jan 1979) (Publ. in Handbook of Noise Control, Chapter 41, pp 41-1 - 41-8, Jan 1979)
PB80-103807

Key Words: Regulations, Noise generation

This publication is a short book chapter for The Handbook of Noise Control, Second Edition (McGraw-Hill). A description is given of existing and pending Federal regulations on the noise emission from new products.

BIBLIOGRAPHIES

80-1235

Earthquake Engineering: Buildings, Bridges, Dams, and Related Structures. Volume 3. October 1977 - August 1978 (A Bibliography with Abstracts)

G.E. Habercom, Jr.

National Technical Information Service, Springfield, VA, 119 pp (Oct 1979)

NTIS/PS-79/105Q/8GA

Key Words: Bibliographies, Seismic design, Bridges, Buildings, Dams

Seismic phenomena relative to buildings, bridges, dams, and other structures are investigated. Damage assessment is made and design inadequacies are revealed. Suggestions for structural improvements for dynamic response are presented. Abstracts on site selection and earthquake-proofing for atomic power plants are included. (This updated bibliography contains 112 new abstracts.)

80-1236

Earthquake Engineering: Buildings, Bridges, Dams, and Related Structures. Volume 4. September 1978 - August 1979 (A Bibliography with Abstracts)

G.E. Habercom, Jr.

National Technical Information Service, Springfield, VA, 211 pp (Oct 1979)

NTIS/PS-79/1051/6GA

Key Words: Bibliographies, Seismic design, Bridges, Buildings, Dams, Nuclear power plants

Seismic phenomena relative to buildings, bridges, dams, and other structures are investigated. Damage assessment is made and design inadequacies are revealed. Suggestions for structural improvements for dynamic response are presented. Abstracts on site selection and earthquake-proofing for atomic power plants are included. (This updated bibliography contains 204 new abstracts.)

USEFUL APPLICATIONS

80-1237

Atomization of Liquid by Ultrasonic Vibration (On the Vibrating Circular Disc of a Large Area)

C. Chiba

The Technical College, Yamagata Univ., Yonezawa City, Japan, Bull. JSME, 22 (172), pp 1431-1438 (Oct 1979) 11 figs, 5 refs

Key Words: Disks (shapes), Vibrating structures

For the purpose of clarifying the relationship between the vibration modes of amplitudes and the atomization, the amplitudes are measured on the vibrating circular disc of a large area, and the mode vibration is experimentally and theoretically examined. In this paper, the methods of efficient atomization, the mean droplet diameter, the droplet size distribution, etc. are investigated.

80-1238

Analysing the Hopping Conveyor

G. Winkler

Fachhochschule Flensburg, Flensburg, Federal Republic of Germany, Intl. J. Mech. Sci., 21 (11), pp 651-658 (1979) 11 figs, 6 refs

Key Words: Materials handling equipment, Conveyors, Vibrating structures

The most common type of vibrating conveyor consists of a track that oscillates in a straight line inclined with respect to the horizontal, but does not have any net motion. Particles placed on the track advance because of the variation in normal and friction forces during the forward/upward and backward/downward strokes. In the present paper, the performance prediction is extended to the regime of hopping, which occurs when the vertical track acceleration exceeds the gravitational constant. Great emphasis is given in the paper to the non-dimensional representation of all variables, which reduces the number of design and performance parameters from the usual five dimensional ones to three non-dimensional ones.

AUTHOR INDEX

TECHNICAL NOTES

M.N. Bismarck-Nasr and H.R.C. Savio
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AIAA J., 17 (10), pp 1148-1150 (Oct 1979) 1 fig, 2 tables, 15 refs

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W.R. Spillers, A.N. Greenwood, and G. Spiliotis
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J. Test Eval. (ASTM), 7 (5), pp 297-299 (Sept 1979) 8 figs, 2 refs

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Application of Sensitivity Analysis to Car-Trailer Stability
J. Dyn. Syst., Meas. and Control, Trans. ASME, 101 (3), pp 272-274 (Sept 1979) 1 fig, 1 table, 11 refs

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J. Sound Vib., 66 (1), pp 144-147 (Sept 8, 1979) 1 table, 4 refs

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Numerical Analysis of Vibration of Beams Subjected to Moving Loads
J. Sound Vib., 65 (1), pp 147-150 (July 8, 1979) 2 figs, 6 refs

M.F. Modest and J.A. Tichy
The Slider Bearing with Small Superimposed Normal Oscillations, Including the Effect of Fluid Inertia
ASLE Trans., 22 (4), pp 358-360 (Oct 1979) 3 figs, 3 refs

D. Favier, J. Rebont, and C. Maresca
Large-Amplitude Fluctuations of Velocity and Incidence on an Oscillating Airfoil
AIAA J., 17 (11), pp 1265-1267 (Nov 1979) 4 figs, 10 refs

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Modal Analysis of the Transient Asymmetric Response of Thin Circular Plates
AIAA J., 17 (11), pp 1274-1275 (Nov 1979) 1 fig, 1 table, 8 refs

CALENDAR

MAY 1980

11-14 1980 Annual Technical Meeting & Equipment Exposition [IES] Philadelphia, PA *(IES Hq.)*

19-23 Fourth International Conference on Pressure Vessel Technology [ASME] London, England *(ASME Hq.)*

25-30 Fourth SESA International Congress on Experimental Mechanics [SESA] The Copley Plaza, Boston, MA *(SESA Hq.)*

JUNE 1980

11 Experimental Techniques for Fatigue Crack Growth Measurement [SEE] British Rail Technical Centre *(SEE Hq.)*

22-26 Summer Annual Meeting [ASME] Waldorf-Astoria, New York, NY *(ASME Hq.)*

JULY 1980

7-11 Recent Advances in Structural Dynamics Symp., [Institute of Sound and Vibration Research] University of Southampton, Southampton, S09 5NH, UK *(Mrs. O.G. Hyde, ISVR Conference Secretary, The University, Southampton, S09 5NH, UK - Tel (0703) 559122, Ext. 2310)*

SEPTEMBER 1980

2-4 International Conference on Vibrations in Rotating Machinery [IMechE] Cambridge, England *(Mr. A.J. Tugwell, Institution of Mechanical Engineers, 1 Birdcage Walk, London SW1H 9JJ, UK)*

8-11 Off-Highway Meeting and Exposition [SAE] MECCA, Milwaukee, WI *(SAE Hq.)*

OCTOBER 1980

Stapp Car Crash Conference [SAE] Detroit, MI *SAE Hq.)*

Joint Lubrication Conference [ASME] Washington, D.C. *(ASME Hq.)*

6-8 Computational Methods in Nonlinear Structural and Solid Mechanics [George Washington University & NASA Langley Research Center] Washington, D.C. *(Professor A.K. Noor, The George Washington University, NASA Langley Research Center, MS246, Hampton, VA 23665 - Tel (804)827-2897)*

21-23 51st Shock and Vibration Symposium [Shock and Vibration Information Center, Washington, D.C.] San Diego, CA *(Henry C. Pusey, Director, SVIC, Naval Research Lab., Code 5804, Washington, D.C. 20375)*

NOVEMBER 1980

18-21 Acoustical Society of America, Fall Meeting [ASA] Los Angeles, CA *(ASA Hq.)*

DECEMBER 1980

Aerospace Meeting [SAE] San Diego, CA *(SAE Hq.)*

8-10 INTER-NOISE 80 [International Institute of Noise Control Engineering] Miami, FL *(INTER-NOISE 80, P.O. Box 3469, Arlington Branch, Poughkeepsie, NY 12603)*

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Washington, D.C.

AHS: American Helicopter Society
1325 18 St. N.W.
Washington, D.C. 20036

AIAA: American Institute of Aeronautics and Astronautics, 1290 Sixth Ave.
New York, NY 10019

AIChE: American Institute of Chemical Engineers
345 E. 47th St.
New York, NY 10017

AREA: American Railway Engineering Association
59 E. Van Buren St.
Chicago, IL 60605

ARPA: Advanced Research Projects Agency

ASA: Acoustical Society of America
335 E. 45th St.
New York, NY 10017

ASCE: American Society of Civil Engineers
345 E. 45th St.
New York, NY 10017

ASME: American Society of Mechanical Engineers
345 E. 45th St.
New York, NY 10017

ASNT: American Society for Nondestructive Testing
914 Chicago Ave.
Evanston, IL 60202

ASQC: American Society for Quality Control
161 W. Wisconsin Ave.
Milwaukee, WI 53203

ASTM: American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103

CCCAM: Chairman, c/o Dept. ME, Univ. Toronto,
Toronto 5, Ontario, Canada

ICF: International Congress on Fracture
Tohoku Univ.
Sendai, Japan

IEEE: Institute of Electrical and Electronics Engineers
345 E. 47th St.
New York, NY 10017

IES: Institute of Environmental Sciences
940 E. Northwest Highway
Mt. Prospect, IL 60056

IFToMM: International Federation for Theory of Machines and Mechanisms
U.S. Council for TMM
c/o Univ. Mass., Dept. ME
Amherst, MA 01002

INCE: Institute of Noise Control Engineering
P.O. Box 3206, Arlington Branch
Poughkeepsie, NY 12603

ISA: Instrument Society of America
400 Stanwix St.
Pittsburgh, PA 15222

ONR: Office of Naval Research
Code 40084, Dept. Navy
Arlington, VA 22217

SAE: Society of Automotive Engineers
400 Commonwealth Drive
Warrendale, PA 15096

SEE: Society of Environmental Engineers
6 Conduit St.
London W1R 9TG, UK

SESA: Society for Experimental Stress Analysis
21 Bridge Sq.
Westport, CT 06880

SNAME: Society of Naval Architects and Marine Engineers
74 Trinity Pl.
New York, NY 10006

SPE: Society of Petroleum Engineers
6200 N. Central Expressway
Dallas, TX 75206

SVIC: Shock and Vibration Information Center
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51st SHOCK AND VIBRATION SYMPOSIUM
San Diego, CA, 21-23 October 1980
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